THE ROLE OF KNOWLEDGE TRANSFER IN PARTICIPATORY ERGONOMICS: EVALUATION OF A CASE STUDY AT A POULTRY PROCESSING PLANT

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The role of knowledge transfer in participatory ergonomics: Evaluation of a case study at a poultry processing plant

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ABSTRACT

Aims:

This project involved the evaluation of a transfer of a `train-the-trainer' knife sharpening and steeling program (KSP) for butchery operations from Québec to Newfoundland. The objectives of this study were to evaluate: 1) the factors that impacted upon the transfer of the KSP from a Québec Research Team (QRT) to the Newfoundland Research Team (NRT) and a poultry plant, 2) to evaluate the impact of the KSP on employee health and productivity and, 3) to attempt to identify the impact that a KT strategy has within a participatory ergonomics (PE) intervention. The Eastern Canadian Consortium on Workplace Health identified the KSP as a successful existing program that could be transferred to Newfoundland and Labrador. It was thought that this program would benefit a St. John's, Newfoundland poultry processing plant. Researchers (ergonomists, engineers and KT specialists), plant management and plant employees constituted a tripartite partnership that would guide the knowledge adaptation, transfer and assimilation. The KSP uses a 'train-the-trainer' approach that identified plant personnel who could acquire the ability to machine-sharpen knives. Following a series of training sessions, the plant trainers were asked, in cooperation with factory management, to proceed with training of plant workers in proper knife steeling and care techniques. The QRT provided the NRT with methods to assess skill development and work behavior changes of a production line cohort. Researchers adapted survey, video and semi-structured interview techniques to assess the intervention. A KT Model (Parent et al., 2007) was employed as a diagnostic tool to evaluate KT capacities. While KT was slow and was not completely successful, the project recognizes that KT capacities within social networks impacted on the KSP intervention. Networks for actor communications, managerial involvement, organizational culture and facilitative ability of the NRT appear to have impacted disseminative and absorptive capacities required for successful KT. The QRT and the trainers displayed active generative capacity, by developing new knowledge regarding the KSP process, and strategies to use in smaller enterprises. The NRT gained experience in applying a PE framework. However, it is clear that additional steps are required for the knowledge gained within the province from the experience to become institutionalized. At the industrial site, the trainer's skills and knowledge have been recognized as exceptional by the QRT and Québec experts. Some, but not all, employees have adopted the principles of the KSP and demonstrate the potential for reductions in cutting-related musculoskeletal disorders. However, managers at the plant did not taken steps to institutionalize knowledge, suggesting that the continuity of the KSP may be threatened.

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LIST OF ABBREVIATIONS

CIHR	Canadian Institutes of Health Research
IRSST	Institut de recherche Robert-Sauvé en santé et en sécurité du travail
KSP	Knife sharpening and steeling program
KT	Knowledge Transfer
NL	Newfoundland and Labrador
NRT	Newfoundland Research Team
PE	Participatory Ergonomics
QRT	Quebec Research Team
WHSCC	Workplace Health, Safety Compensation Commission

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Chapter 1: Introduction

1.1 Introduction

Organizations continually strive to obtain new knowledge. The field of knowledge transfer (KT) investigates the process of moving knowledge from donors to recipients and the factors that impact on these exchanges. KT evolved from management and business fields in response to evidence that those organizations that have efficient KT strategies have the greatest success in business (Argote, Ingram, Levine, & Moreland, 2000). Companies now view the management of their knowledge, rather than of their material resources, as the top priority and asset (Earl, 2001). Although much of the work in KT grew from the business and management literature, other disciplines have recognized a need to develop and implement KT strategies within their own organizations and networks.

Health professions have implemented KT strategies in response to self-realizations and outside criticisms regarding the failure to move research results from the laboratory into practice. In 2005-06, 776.8 million dollars was allocated for funding of health research in Canada (Bernstein, 2005). In spite of all the substantial monetary resources devoted to health research, the dissemination of results remains a slow and often disorganized process (Graham et al., 2006). Research is often investigator driven and the process is considered completed once the information reaches a peer-reviewed academic publication. Under such conditions, publicly-funded research findings may not reach policy makers, health care professionals, or end-users in a timely and direct fashion (Lavis, 2006). There is clearly a need to bridge the knowledge-to-application gap (Pablos-Mendez & Shademani, 2006). In response to the need to bridge this gap the Canadian Institutes of Health Research (CIHR) introduced a knowledge translation strategy in 2004. The strategy stated that to enhance KT, researchers and policy makers must learn from past experience, avoid duplication of effort, and establish partnerships with regional, national, and international organizations.

Occupational health and safety (OHS) is a research field that would benefit from well-developed knowledge-to-action strategies. Knowledge is often considered the central resource in OHS and ergonomic interventions (Sherehiy & Karwowski, 2006) and creating a knowledge-to-action plan in OHS has a particular importance to Atlantic Canada. Many Atlantic Canadian industries are founded on natural and renewable resources and are typically located in remote and rural regions. Under such isolated conditions, these companies often lack the infrastructure to support OHS programs. The financial resources to support company-based OHS programs, access to the programs by all employees, and the capacity to conduct research to inform policy and practice are typically limited. It is often difficult for some smaller and more remote enterprises to gain access to basic and specialized health care and prevention services. Thus, the creation of policy and guidelines to create a safe-work culture is more difficult compared to larger provinces and metropolitan centres. Perhaps OHS programs and intervention strategies that are already developed and have proved successful in other jurisdictions can be transferred to these smaller centers, rather than duplicating past research efforts.

This thesis is a participant-observer's investigation of the transfer of an ergonomic program from Québec to Newfoundland and Labrador (NL). The program involves a participatory ergonomics (PE) approach to implementing a knife sharpening and steeling program for butchery operations. A PE intervention requires involvement of management, employees, union, engineering, and other divisions of the plant in the intervention (Koningsveld, Dul, Van Rhijn, & Vink, 2005; de Looze, Urlings, Vink, Van Rhijn, & Miedema, 2001; Haines, Wilson, Vink, & Koningsveld, 2002; Saleem, Kleiner, & Nussbaum, 2003). The involvement of such key stakeholders allows the participants to become educated on ergonomic issues, select intervention strategies, and help to design, adapt, and implement the selected solution based on professional, industrial, and day-to-day operational requirements. The success of the PE intervention requires knowledge exchange between key stakeholders, and unsuccessful KT, at any level, will impact on the final successes of the intervention.

1.2 Context

Butchery operations within the food-processing sector are associated with a high incidence of musculoskeletal injury (MSI) in the Province of Newfoundland and Labrador. The Worker's Health and Safety Compensation Commission (WHSCC) of Newfoundland and Labrador reports that from 1998 to 2004, the total number of reported lost-time soft-tissue claims thought to have resulted from repetitive motions for fish plant, slaughtering and meat-cutting occupations in the poultry, supermarket and fish processing sectors was 261. Of these claims, 188 (72%) were related to the fingers, hands, wrist, arms or shoulders.

Research investigating the impact of blade sharpness on physical exposure during butchery operations supports the claims of high incidence of injury. McGorry, Dowd & Dempsey (2003) found that blade sharpness affects the force required to perform meat-cutting operations and could significantly impact the risk of upper extremity injury. Claudon & Marsot (2006) reported that decreased blade sharpness resulted in significantly higher activity of muscles in the forearm and shoulder, while O'Sullivan & Gallway (2005) and Claudon & Marsot (2006) report that decreased blade sharpness results in non-neutral postures of the wrist. Szabo, Radwin, & Henderson (2001) suggested that performing a steeling task on a butchery blade with sufficient regularity reduces the force requirement to complete cutting operations by maintaining the integrity of the blade's cutting edge. A program in knife sharpening and steeling should impact upon the incidence of soft-tissue injuries and improve productivity of the work operations.

1.3 Research framework

This project was included within a series of projects stemming from a CIHR Interdisciplinary Capacity Enhancement (ICE) Grant. The grant allowed the establishment of the Eastern Canada Consortium on Workplace Health and Safety. Members of this Consortium included:

1. *SafetyNet: Community Alliance for Maine and Coastal Workplace Health and Safety in Atlantic Canada*, Faculty of Medicine, Memorial University of Newfoundland.
2. *The CEOT: Chaire d'etude en organisation du travail*, Faculty of Business Administration at the University of Sherbrooke
3. *IRSST - Institut de recherche Robert-Sauvé en santé et sécurité du travail*

The Consortium proposed to develop capacity for SafetyNet researchers to adopt effective KT strategies within research projects on workplace health and safety. The IRSST is a well established and funded research organization based in Montreal, Québec. In collaboration with KT experts at the CEOT, SafetyNet selected several IRSST programs for transfer and adaptation in NL. These program transfers would serve as test beds for creating capacity within NL researcher's to move OHS knowledge to more rural and remote Canadian regions.

A Québec-based knife sharpening and steeling program evolved from the work of a group of engineering and ergonomics experts, in partnership with employees from several pork processing plants. It was identified as a desirable program for transfer to Newfoundland. The program initially emerged in Québec as an ergonomic intervention strategy funded partly by the Institut de recherche Robert-Sauvé en santé et sécurité du travail (IRSST). Through continued work of Vézina, Prévost, & Lajoie (2000) and the IRSST, a 'train-the-trainer' program in knife sharpening and steeling was developed. The program focused on training individuals at plants to become experts in established methods of sharpening using a machine-grinder and in properly performing knife steeling to maintain the cutting edge of the blade. These knife-experts, or trainers, then teach fellow-employees the theory of steeling in a classroom setting and the practical skills of sharpening and steeling through a series of interactions on the production line. The ergonomists, in such a PE framework, act as facilitators during the project to: 1) move the trainers through the stages of theoretical learning and skill development, 2) facilitate exchanges between the knife expert and plant trainers, and 3) examine the worksite for related health, safety and production problems. The program has met with success in

Québec in terms of reduced injury rates and improved productivity. As a result, many Québec companies have requested the program to be implemented in their plants. It was assumed that a similar program would meet with like-successes in Atlantic Canada.

Several food-processing plants in NL were identified as potential sites for the program's transfer and implementation. A poultry processing plant was chosen as the initial partner for the program. In one particular area of the plant, employees used knives constantly during work operations to cut away remaining bones and other defects in the poultry breast. This *deboning* line became the intervention site at the plant.

Despite the relevance of the program and the potential benefit to Newfoundland industry, several factors can have an impact on the transfer of this program to Newfoundland from Québec: 1) the challenges of moving a program to a different culture and language; 2) organizational and economic differences between companies and provinces; 3) the lack of experience of the Newfoundland's ergonomists and researchers in conducting this type of intervention; and (4) the absence of any history of this invention style at the chosen industrial site.

The transfer of the knife sharpening and steeling program (KSP) had two objectives: 1) to allow the NRT to observe the QRT in order to develop capacity to undertake PE interventions in this 'train-the-trainer' program, and 2) to determine how successful the QRT, and later the NRT, could be in implementing the PE KSP within plants selected for the project.

The transfer of the knife sharpening and steeling program included three phases (Figure 1.1) and the present thesis will investigate phase 1 of this program. In this phase the QRT were responsible for running the PE train-the-trainer program, while the NRT observed the process to develop their capacity for future plants. In a calculated manner the NRT would increase their role throughout the duration of the project in order to maintain contact with key stakeholders and particularly during the absence of the QRT who were available to travel from Québec and visit the plant only periodically. The goal of the first phase of the project was to have the NRT learn to facilitate the program during subsequent program phases.

The role the author of this thesis undertook during the first phase of project, and the focus of this thesis, was to observe the QRT as they delivered the program at the plant, and to evaluate the use of the knife sharpening and steeling program on the deboning line. Rather than focus on epidemiological evidence for reductions in workplace injury the objectives of this thesis involved investigation of the participatory ergonomics and knowledge transfer processes contained within the KSP and the potential benefits offered by such a project. Specifically these objectives were: 1) to study the factors that had an impact on the transfer of the KSP from a Québec Research Team (QRT) to the Newfoundland Research Team (NRT) and to a poultry plant, 2) to evaluate the impact of the KSP on employees' work behavior and productivity and, 3) to attempt to identify the impact that a KT strategy has within a participatory ergonomics (PE) intervention. KT models are not usually included in PE frameworks, but perhaps these models can provide a useful diagnostic tool to evaluate the present project's objectives. The Dynamic Knowledge Transfer Model (Parent, Roy, St-Jacques, 2007) was employed to evaluate the exchanges between researchers and key plant stakeholders.

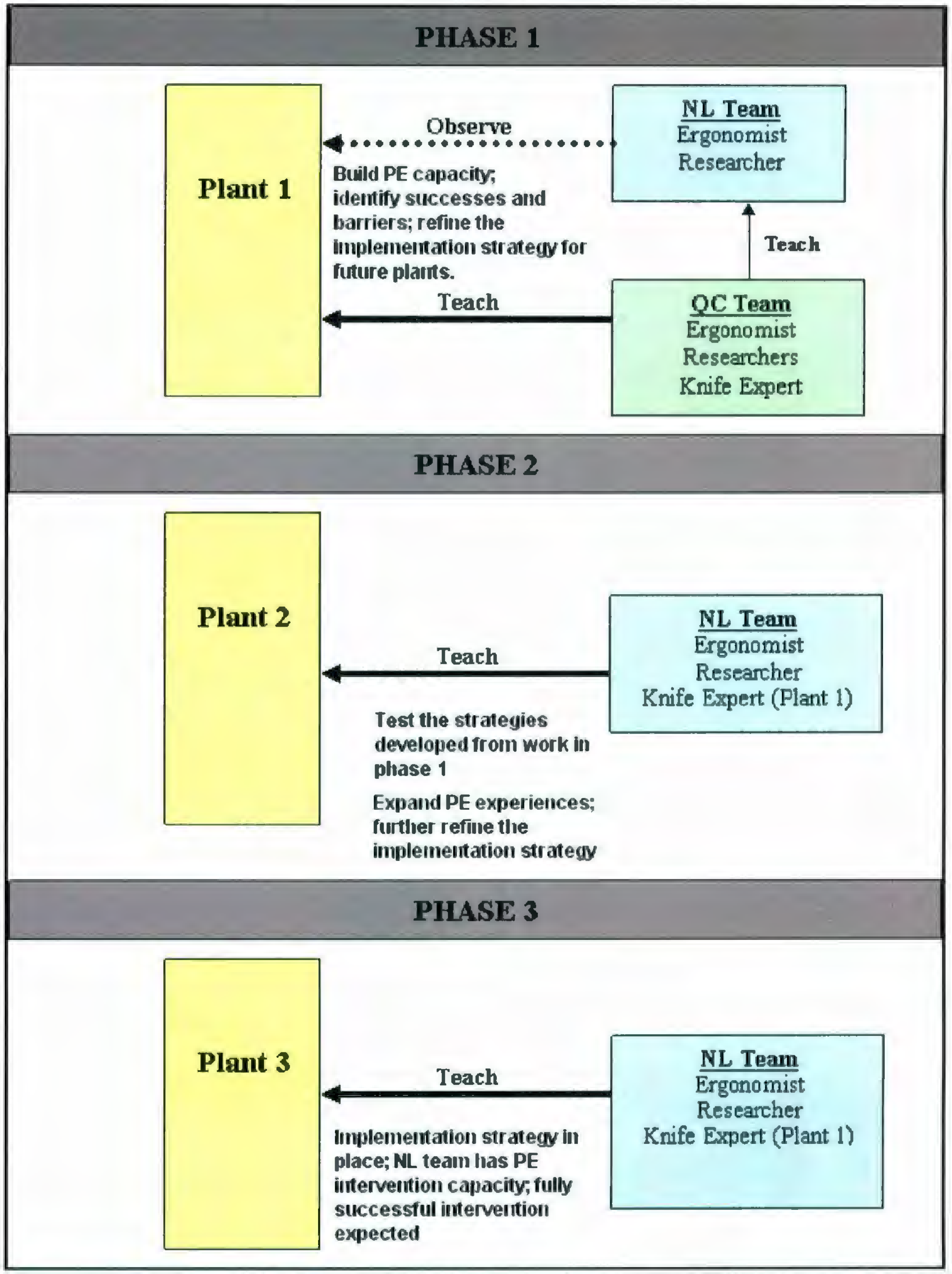


Figure 1.1: Outline of the Eastern Canada Consortium on Workplace Health and Safety's knife sharpening and steeling program

Chapter 2: Review of Literature

OHS and ergonomics interventions have traditionally focused on applying clinical or lab-based experimental evidence to the workplace. Despite the identification of risk factors for musculoskeletal injuries (MSI), the prevalence of MSI is still a major concern in many working environments. Carrivick, Lee, Yau, & Stevenson (2005) questioned whether the ergonomic information being implemented in workplaces is properly adapted and applied. Upon further reflection, it is perhaps the style of the ergonomic interventions, rather than the scientific basis of the interventions that may be the issue. Risk factors for MSI are known to include physical, psychosocial, and psychophysical components (Theberge, Granzow, Cole, & Laing, 2006). Perhaps traditional ergonomic interventions are too concerned with dealing with individual factors one at a time when an intervention should really consider all factors simultaneously in a more holistic manner.

In many cases, an ergonomist, particularly a third-party consultant, will have difficulty dealing with the multifaceted nature of MSI because he or she does has no first-hand knowledge of the work organization and even less knowledge about the individuals employed at the company and the tasks performed within it. Ergonomists should involve the end-users to assure that their intervention recommendations are consistent with the day-to-day operations of the workplace and are acceptable to stakeholders at all levels. In the last twenty years a participatory approach to ergonomics has emerged. In this approach, stakeholder participation is recognized as being critical to the success of the intervention (McNeese, Zaff, Citera, Brown, & Whitaker, 1995). Participatory ergonomics (PE) can result in improvements in employee satisfaction, a better designed workstation, increases in quality of the products and output, and increased profit (Nagamachi, 1995).

Even with the potential benefits of a PE paradigm, this style of intervention can face barriers to success. PE and traditional ergonomic interventions often fail because receptors have difficulty accepting or understanding change (Vink, Peeters, Grundemann, Smulders, Kompier, & Dul, 1995; de Jong & Vink, 2000). The intervention process tends to identify, up front, issues such as poor employee training and practices, undesirable work conditions and/or work:rest ratio issues. If the intervention specialist does not frame these findings appropriately, negative reactions from employees and employers are likely to occur, creating poor buy-in from key stakeholders (Vink, Koningsveld, & Molenbroek, 2006). Participatory approaches force stakeholders to move new knowledge and resources into action. These outcomes must improve occupational health and other work-related issues (Kogi, 2006). Stakeholders are able to understand better the issues at hand and work together to develop required solutions. However, moving knowledge between stakeholders can be impacted by personal, organizational and contextual factors. It appears that KT within a social system can be affected by: 1) the difficulty noted in having receptors absorb and apply knowledge, 2) difficulty in having key stakeholders understand the intervention design, and 3) difficulty in promoting exchange between stakeholders.

An interdisciplinary approach to PE interventions may be able to overcome the barriers to KT. Theberge et al. (2006) stated that social sciences may provide greater clarity on the factors that limit PE. Bohr, Evanoff, & Wolf (1997) noted that application of KT literature can alleviate some of the difficulties in PE. This type of reasoning has led to the integration of industrial relations, communications, business and management theories and practices into ergonomic interventions.

Reviewing the PE literature can further identify the strengths and weaknesses of this style of intervention, as well as identify requirements that must be met at industrial sites to ensure that the success of this approach. In addition, a clearer understanding of potential barriers to knowledge exchange within a participatory approach is required; to do so will require a review of the literature on KT. The present literature review intends to cover these topics in an attempt to outline more clearly the relationship between KT and PE.

2.1 Participatory ergonomics

In the past, ergonomics was thought of as a discipline concerned with the enhancement of the employee-system interaction (O'Neill, 2000), where the system under consideration is often restricted to direct aspects of a work task. In more recent years a broader definition of the *system-interaction* with ergonomics has evolved. The International Ergonomics Association (IEA) defines Ergonomics as:

> … the scientific discipline concerned with the fundamental understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data and methods of design in order to optimize human well-being and overall system performance. (IEA, 2000)

This broad definition suggests that all elements (e.g., stakeholders) must be considered in the overall evaluation of a work process. It also highlights the shift in practitioner perspective from a microergonomic view to one at a macro level. More traditional ergonomic interventions tended to focus on a single workstation or production problem, while a new approach to ergonomics considers the importance of whole organizational structures and systems in intervening in an ergonomic problem (Hignett, Wilson, & Morris, 2005). PE represents an intervention style to work within a systemic approach to ergonomics. However, in order to ensure that success, a PE approach requires adaptation of social, organizational, and industrial contexts pertinent to an organization (Kuoridnka, 1997). In order to adjust these contexts, stakeholders are included in the intervention process, thereby accounting for traditional ergonomic measures (e.g., machinery, tools, postures) as well as organizational and employee/management factors. Securing stakeholder participation involves gaining a commitment from employees and management to work in collaboration to identify risks and choose solutions to fit the needs of the entire group (Anema, Steenstra, Urlings, Bongers, de Vroome, & van Mechelen, 2003). In this way, the intervention design is more readily accepted by the different levels of the organization, thereby improving the chances of success. Laitinen, Saari, Kivisto, & Rasa (1998) state that involving employees in the change process can improve the quality of their work life, as they see their role within the company to have greater purpose. In general, participatory approaches have benefits beyond the improvement of the particular work issue at hand.

There is a variety of definitions that attempt to encompass PE (refer to Table 2.1). Although there is no consensus on a definition of PE, there is one common element in all of the descriptions; the involvement of stakeholders in the process. Failure to involve employees, management, and other key stakeholders in the process may lead them to negatively interpret the need for the intervention and to see possible outcomes as threatening (Saleem et al., 2003). Involving the employees makes them more likely to accept the changes (Saleem et al., 2003) and ensure that that the implementation of the program is realistic and consistent with production requirements (St. Vincent, Kuorinka, Chicoine, Beaugrand, & Fernandez, 1997).

Table 2.1: Definitions of "participatory ergonomics" in the literature

Definition	Source
A program that involves the end-users of the technology/plans in the implementation stage	Imada (1991)
The active involvement of employees in implementing ergonomic knowledge in the workplace.	Nagamachi (1995)
A term used to describe an ergonomics management program	Wilson & Haines (1997)
A method for involving workers in analyzing and redesigning their job	Saleem et al. (2003)

The way in which the employees and managers fit into the participative model is crucial to the success of the PE process. Participation can occur as direct involvement, where all the workers are involved in the process, or representative involvement, where different departments and organizational levels are represented by individuals on a committee or project (Haines, Wilson, Vink, & Koningsveld, 2002; St. Vincent et al., 1997.). Koningsveld, Dul, Van Rhijn, & Vink (2005) reported in their list of critical factors that attaining management support helps to ensure that that solutions are implemented, improves momentum for future projects, and shows employees that the work completed is meaningful. Maintaining close contact with management by having them represented in the PE project can also ensure that the project is treated with sufficient priority at the plant. In general, full participation of operators, supervisors and managers helps to ensure that good results, even if their participation is achieved by representative methods (Maciel, 1998).

Although representative participation is useful to ensure that that many different departments within a company are represented, direct participation can offer greater benefit. With direct involvement, the end-users of the designed intervention have a direct hand in the project, rather than relying on nominated individuals to apply the knowledge for them. Using as direct a participative approach as possible also helps to ensure that the information is getting to the stakeholders in the most engaging way (de Looze, Van Rhijn, Van Deursen, Tuinzaad, & Reijneveld, 2003). Direct involvement can allow employees an opportunity to gain procedural knowledge and internalize its application to the production process and occupational health mandate. However, even when direct involvement of end-users is assured in PE, the type and duration of involvement also plays a role; the involvement of end-users often requires training sessions on ergonomic principles (Lanoie & Tavenas, 1996).

The training offered in PE programs can take several forms. However, when selecting media for training, lectures may not be the best choice, as they do not allow active engagement of the employees (Burke, Sarpy, Smith, & Chan-Serafit, 2006). The more engaged the employees become, the more likely they are to find the training meaningful. Use of learning tools such as video and computer-based learning has shown slightly higher engagement then lecture-based strategies; however, using strategies that consist of observing a role model, hands-on demonstration, and two-way communication allows for more measurable behavioral change (Burke et al., 2006). Employees should feel as though they are an active part of the program rather than inert receptacles of the knowledge (St. Vincent et al., 1997).

Managers may not need to have the same level of in-depth training as employees and end-users of the PE intervention, but their involvement remains critical (Laing et al., 2005; Haines et al., 2002; de Looze et al., 2001; Koningsveld et al., 2005; Maciel, 1998). Managerial support ensure that that employees buy into the project, that financial and logistical supports are in place for the project, and that the project maintains momentum. Much like employees, managers must be actively engaged in the project if their level of commitment is to be fostered. Engaging managers in the early stages of the project and giving them an accurate outline of the project's steps can clearly outline the lines of communication that management must maintain between project members to ensure that success. In many cases managers will only commit to a project if the style of intervention has potential economic benefit to the company.

Management may benefit from investment in a PE intervention in that it can reduce MSI, as these injuries result in significant economic loss for companies. On the other hand, ergonomic interventions involve a commitment of personnel and financial resources for both training and equipment purchases. In the short term, the cost of the intervention may exceed the potential gains in direct costs, such as reduced employee absenteeism and reduced short-term compensation costs. However, if indirect costs such as lost production time and the cost of training replacement employees are considered, the potential economic gain from the intervention is more substantial (Carrivick et al., 2006; Lanoie & Tavenas, 1996). Additionally, evaluating the investment in the long term, rather than the short term, may prove the intervention was economical; if an MSI becomes a chronic problem there is likely to be a long-term impact of paying for long-term disability and increases in workers' compensation premiums. At this point, the initial investments in the intervention are likely to be much less than the long-term cost of injuries, particularly in industries with a high incidence of injury (Riel & Imbeau, 1997). If ergonomics is properly applied it also has the potential to benefit the company from a marketing and productivity perspective (Kogi, 1997; Vink et al., 2006)

One such example of economic gains produced by a committed partnership between management and employees during a PE project is described by Anema et al. (2003). They report that using PE as a return-to-work strategy showed excellent cooperation on the part of employee, supervisor, medical team, and management, and also had a high adherence and satisfaction level for the employees involved. This type of program subsequently kept employees in a working environment, rather than on workers' compensation, and allowed them to gain the knowledge required to prevent injury in the future. This shows active involvement during a rehabilitation phase and proactive approaches to preventing injuries in the future. The company benefited by not having to pay compensation fees, avoided increases in compensation premiums, and took steps towards preventing future injury. Another example of the potential benefits of a PE program is presented by Lanoie & Tavenas (1996). Their case study showed that investment into a PE program resulted in slight loss in the early years of the program, but tremendous savings through reduced direct and indirect costs five years after implementation. These examples highlight the potential gains at an economic level for a company. However, these gains are only possible if there are improvements in workplace factors for the employees.

In terms of benefits to employees, there is potential for improvement in health and quality of work life. From a health perspective, the use of PE to reduce injuries and accident rates, particularly MSI, has increased in recent years (Anema et al., 2003). Although risk factors such as load, repetition, and posture are know risk factors for the development of MSI (Carrivick et al., 2005), Theberge et al. (2006) cite evidence that physical, psychophysical, and psychosocial components of a job interact to create MSI risk. Eklof, Ingelgard, & Hagberg (2004) state that the uncertainty over the best strategy to reduce physical and social stressors may stem from the individual, social, and organizational factors which mediate the intervention, or these factors may serve as risk factors on their own. The findings in the literature suggest that PE is effective at reducing injuries because it can target physical, psychological, and social risk factors in its intervention strategy. By having both employees and management offer input into the intervention, employees are generally more satisfied with their job, improving their mental and social satisfaction. Involving employees and management also creates a social and organizational culture with an impact on the psychophysical and psychosocial portion of the intervention, while the development of a sound physical intervention may alleviate physical risk components (Laitinen et al., 1998).

Not only can a PE-style intervention benefit the mangers and employees of companies, but it can also improve the impact of ergonomics as a whole. For example, many rural and remote workplaces cannot support continued ergonomics consultancy; however, it is desirable for all businesses to establish policy and programming with respect to internal ergonomics and OHS surveillance (Carrivick et al., 2005; St. Vincent et al., 1997). By considering a PE model we can build the foundation for ergonomic improvements within the individual firm level. In the long term, this would decrease the amount of time required for the ergonomist to spend at each intervention and have him or her act only as consultants to evaluate the program, assist in the implementation of the agreed upon solutions, and facilitate exchanges within the firm when required. Ergonomics is not often considered a high priority in companies, meaning that the solutions suggested by ergonomists are often questioned or rejected (Koningsveld et al., 2005). By using PE, education in the field of ergonomics is provided to the employees and management, increasing their understanding of the need for ergonomics and its potential benefits. In this way, PE offers a way to make ergonomics a more readily accepted and applied discipline in industry as well as improving the emphasis placed on OHS in general. In this manner PE can enhance OHS culture in industries, reduce physical risk factors for injury within a company, and account for political-social factors in the intervention.

A community-based social benefit has also been noted following the use of some PE programs. Ergonomics has long been used to increase productivity and give greater potential for economic gain. As a result, ergonomics can have positive impacts on the economic status of a company, which in term can improve the wages for employees and drive the economy of the surrounding area. However, in areas where engineering and consultancy costs exceed the economic capacity of the company, the company is unable to improve their status. Recent work suggests that in industrially developing countries (IDC), where financial resources limit consultancy and engineering, PE holds potential for social and economic improvements (O'Neill, 2000; 2005). O'Neill (2000) reports that production processes in IDC primarily involve manual labor. O'Neill (2000; 2005) argues that by using PE principles to improve employee knowledge of workstations and work tasks, companies can increase their productivity. This increased productivity should translate into greater corporate wealth and improved wage-compensation for employees. In time, the higher profits and incomes can bring about improvements in housing, education, and the physical and mental health of the community as a whole.

The benefits that a PE approach offers to workplace interventions in IDC may have relevance in remote economic regions of industrially advanced countries. For example, a single company in rural Newfoundland & Labrador may support the employment opportunities for several surrounding communities. In recent decades, following stock declines and fishing moratoriums, vocational out-migration has occurred. As a result, fewer ergonomics, health and engineering consultancies are available to rural industries. Because of the seasonal nature of the work, employees work at high paces over extended work hours in order to qualify for employment insurance. As a result of these factors, MSI are common in these industries, leading to a loss of productivity for the companies and lost time for the employees. Clearly a PE approach to this situation could produce improved overall working conditions and enhanced socio-economic health for these communities.

2.2 Participatory ergonomics research findings

Previous studies on PE interventions and programs outline evidence of potential benefits of PE, possible limitations of the field, and potential lessons and guidelines for PE programs. Reviewing these studies can improve the understanding of the PE paradigm.

One of the critical components listed in PE is the involvement of employees in the ergonomic process. However, the quality of employee produced assessments must be considered. St. Vincent, Chicoine, & Beaugrand (1998) investigated employee ability to comprehend ergonomic principles. They found that training employees to complete ergonomic assessments enabled them to successfully identify ergonomic risk factors. Carrivick et al. (2005) investigated the implementation a PE program for hospital cleaners that involved teaching the employees ergonomic principles for various risk areas, which were previously identified by an ergonomist. Following full training, the employees were able to perform assessments and work as a team to develop solutions to ergonomic problems; the solutions resulted in a reduction in reported injuries in the years following the intervention.

Teaching employees and end-users of the interventions about ergonomic principles is also common for PE programs used with health care workers. The use of a PE program in the health care field is practical as this is an industry with a high risk for MSI and job-stress. Bohr et al. (1997) reported that implementing a PE program in different areas of the hospital showed mixed results. There were successes in reducing MSI in all areas except the intensive care unit. They reasoned that the work hours, work load, time constraints, and lack of available meeting times led to the downfall of the program in this area. Perhaps special considerations for training strategies are needed in situations where there are significant time constraints. In a subsequent study, Evanoff, Bohr, & Wolf (1999) conducted a PE program for hospital orderlies and found that by implementing the program there was a decrease in the number and cost of injuries, lower incidence of MSI, and increased job satisfaction in the years following the intervention. These studies show successes of a PE training program to 1) train unskilled employees to work with ergonomic assessment and intervention strategies 2) reduce MSI issues if the proper cohesive groups are formed to develop a dialogue between PE group members.

In addition to interventions in the formal health care field, there have also been attempts to use PE as a strategy in homecare work as well. OHS regulations and safe work practices are given less consideration in informal workplaces and often employees are unaware of risks (Pohjonen, Punakallio, & Louhevaara, 1998). A PE program consisting of ergonomics training and awareness for homecare workers was effective in reducing physical and metal stressors and ended up being a low cost intervention (Pohjonen et al., 1998). A PE study in a nursing home involved employees being educated on the causes of low-back pain and later forming an ergonomics team that included representative members from the nursing home and an industrial doctor (Udo, Kobayaski, Udo, & Branlund, 2006). The results of the ergonomic training and formation of the ergonomics team resulted in the employees identifying risk factors in their work, and helping to develop low-cost intervention strategies to effectively reduce physical stressors that cause low back pain (Udo et al., 2006). These findings show that PE can serve as an effective method to reduce MSI, even when conducted in less traditional sites, such as single-employee homecare work and nursing homes.

In work settings that are traditionally viewed as being at risk for injury, such as those in construction, butchery, and manufacturing, PE interventions are beginning to show benefits. For workers in construction industries who pour concrete, the physical loads encountered during day-to-day operation are often high. In a study by Hess, Hecker, Weinstein, & Lunger (2004) the use of a PE employee-training program was investigated. The program involved working with employees to train them on ergonomic principles, gain their thoughts on the benefit of using a device known as "slide plates" to aid in moving concrete equipment, and eventually adapt the device for use during work operations. Following the intervention, the authors reported a reduction in the risk factors for back injury. This intervention succeeded in gaining employee support, and through employee involvement allowed adaptation of the equipment to meet the needs of the work operation. These results show that PE is an effective way to introduce occupational health and ergonomics in a manner that will have acceptance by, and benefit to, the employees.

Meat cutting and butchery operations are also known to cause high rates of MSI. Moore & Garg (1998) investigated the creation of a PE group in a meat-cutting operation. They found that since the inception of an ergonomics team, in which management and employees work together, the company had fewer lost-time reports, decreases in workers' compensation costs, and decreased MSI prevalence. Maciel (1998) worked with a synthetic fiber plant to form an ergonomics team consisting of operators, supervisors, medical personnel, engineers, and an ergonomist. He (1998) found that the creation of the team helped each member, and the often the groups they represented, feel a sense of ownership and contribution as well as increased job satisfaction. Laitinen et al. (1998) had similar findings; their results show that a participatory program improved workplace environment and psychosocial aspects of railroad work. These findings support that PE has potential to improve social and psychological factors at the workplace.

In addition to studies of occupations with heavy manual materials handling and the use of PE, there are also reports on PE initiatives in office settings. Ergonomic tools and devices to aid in the office often fail as a result of the individual not knowing how to properly use the intervention tools, or because they are not convinced of their benefit. An approach by Vink et al. (1995) involved educating employees about the nature of the intervention, the background ergonomics and reasons for implementation. The results show that the intervention strategies had a higher adherence and acceptance than previous initiatives because the employees were involved in the identification of problems and the development of, solutions, and were educated on the reasoning behind the choice of particular solutions. These findings may offer further evidence for the benefit of employee involvement and training in OHS interventions in many occupations, not just office settings.

The above applications of PE in industry show that training can no doubt enhance the acceptance and effectiveness of ergonomic interventions. Some examples offer evidence of physical risk factor reduction, while others speak to improvements in social and psychological factors. These findings suggest that there may be evidence of multi-factor improvements. With this insight we can appreciate that the risk factors are inter-related and to truly address one factor, one must address all of them.

Even with the potential benefits of PE and the successes noted in the literature cited, the strategy it is not without its critics. The difficulty involved and the time required for a PE intervention form the basis of the first major criticism noted in the literature. Vink et al. (1995) and de Jong & Vink (2000), by examples, noted that the PE process is rather time consuming, and this time frame may not fit the needs of the employer. A second criticism of PE focuses on the effectiveness of the solutions designed by the employees. In several of the articles cited above, the implementation strategy involved training employees to assess and design solutions independent of the ergonomist. Although there are articles that suggest that the solutions developed by employees were adequate, others note that these solutions were less then optimal (Wilson, 1995) or that the assessments were not always accurate (St. Vincent et al., 1998). Eklof et al. (2004) showed that there was improvement in the psychosocial variables but that there was a lack of conclusive evidence for improvement in the physical risks factors following their PE intervention. They argued that the intervention strategies themselves were insufficient to cause a physical effect. All of these points may suggest that employees themselves do not possess the knowledge or political-social influence within a company to produce ergonomic benefits (Vink et al., 2006).

The PE approach has also been questioned as a result of the lack of conclusive, quantitative, evidence of its effectiveness. Most of the research conducted in this discipline involves case studies and field work at an industrial location where the use of quantitative measures is difficult given the ambiguous nature of the day-to-day PE process. Some argue that improvements noted in the literature could have occurred as a result of extraneous factors, such as organizational and technological changes, rather than the PE intervention (Carrivick et al., 2005). Another problem noted with PE is that, even with success in some firms, there is no universal acceptance or success of the implementation. For example de Jong & Vink (2002) found that bringing together a group of employers and employees from installation work yielded some excellent intervention strategies; however, when individual companies attempted to implement the strategies, some firms found success, other firms had difficulty implementing the strategies, and some firms did not even attempt to implement them. This may lead one to question the effectiveness of PE as it fails to show consistency and a true 'foolproof' implementation strategy.

These concerns over the use of PE as an intervention strategy are valid points. However, these concerns can be overcome with the adaptation of the political and social factors that mediate the process, and the potential benefits of the program may outweigh the limitations. For example, the concerns over the difficulty and the time requirements of PE are convincing. However, the authors who raised these concerns (Vink et al., 1995; de Jong & Vink, 2000) have also championed the use PE and listed benefits throughout their publications. The considerable time it takes to train employees is influenced by organizational constraints and difficulties in KT, rather than the nature of the PE process. Improvements in KT capacity will improve the efficiency of PE projects.

As for the true impact of employee-designed interventions, some studies state that these were effective in reducing risk factors. Nevertheless, it is a reasonable claim that in instances where there is little effect as a result of the PE strategies, additional expertise can help. There are some studies, such as that by Carrivick et al. (2005), which involve the ergonomist completing initial assessments and then teaching the principles to the employees, while being involved in the development of solutions. If the ergonomist were to oversee the project in a facilitative role by visiting the organization periodically, the group could function with a degree of independence, while maintaining guidance. In this manner, the Ergonomist and health and safety professionals could have more time to reach other firms while still insuring the implementation strategy was a sound, scientific, application. Over time the company could learn to deal with their issues with greater independence; perhaps even learning to function with less and less facilitation by the ergonomist.

The concern that PE is founded mostly on case studies with no randomized-controlled experiments to provide evidence is valid. However, those studies that have attempted to quantify the participatory ergonomics effect using randomized-controlled designs still identify positive outcomes. Stalker, Burgess-Limerick, Pollock, & Egeskov (2004) conducted a study in which they assigned a large sample of companies to either an experimental group for PE intervention or a control group to receive no intervention. Government inspectors evaluated the firms in both groups for health and safety protocol and then assigned risk levels. The results showed that the experimental group had a much greater reduction in risk levels than the control group, as compared to their pre-experimental values. In a study by Saleem et al. (2003) an experimental approach to validate PE methods was used. In this experiment the researchers created an experimental group, who received ergonomics training, and a control group, and had the two groups assess a mock workstation. In the opinion of the ergonomics researchers The experimental group identified more risks and developed better scientific interventions to deal with those risks. This suggests that PE training was effective at improving ergonomics capacity, at least in a laboratory setting. Hess et al. (2004) used a lumbar motion monition (LMM) to assess lumbar spine kinematics as predictors of low-back pain risk. They trained concrete pouring employees in ergonomic risk factors and worked with them to adapt the use of a slide-plate to reduce the strain of moving concrete pouring equipment. The results show that the PE approach not only increased the buy-in of the employees but also decreased lumbar spine kinematics, thereby indicating a lowered physical risk of low-back injury (Marras, 1993).

2.3 Participatory ergonomics frameworks

Identifying success factors for PE is an important step to improving upon existing PE frameworks. Although there is no 'foolproof' model or set of guidelines, this is not unexpected as no two organizational cultures, production processes, or groups of employees are identical. Learning from the lessons of previous PE investigations can improve the chance of success, and prepare interventions for possible problems.

Several research groups have used their experience in the field to develop models to guide the PE intervention process. Although these models differ in some aspects of their approach they share many common elements. Laing et al. (2005) cited a participatory ergonomics implementation blueprint developed by Wells, Frazer & Laing (2000) (Wells et al., 2000: available online at http://www.ergonomics.uwaterloo.ca/bprint.html (accessed October 2006). This framework shows a step-by-step progression from identifying problems to designing a solution and implementing it. The model also demonstrates how such factors as management support, organizational culture, and proper tools and knowledge influence the intervention.

Haines et al. (2002) combined the work of previous researchers in the field to develop the Participatory Ergonomics Framework (the PEF). This work attempts to identify the requirements for effective PE. Hignett et al. (2005) cited work which orders the importance of the factors in the PEF. Based on these articles the following points, in order of importance, are considered the most important factors in PE:

1. Decision making process – the amount of influence participants have
2. Mix of participants – having representatives from all levels of the company
3. Approach of the program – developing a process to identify problems, develop solutions, implement the solution, and maintain the change.
4. Role of the ergonomist – as a passive observer to active participant
5. Involvement – The type of participation, direct or representative
6. Focus – determining the scope of PE project and role of the group within the plant

7. Level of influence – the limitation of the groups work as within their own department or across of the plant
8. Company required involvement of employees
9. Permanence of the group beyond the current project

The ranking of the importance of these factors in PE is somewhat surprising as other authors report that the type of employee participation is critically important. De Looze et al. (2001) conducted a study in which they evaluated seven cases of implementing ergonomic solutions into a workstation. They found that for successful implementation the following is required: 1) Direct worker participation and strong management support 2) Use of a stepwise systematic approach for the implementation and training 3) Use a variety of measures to evaluate success, not just musculoskeletal load changes 4) Have a responsible group in charge of the project 5) Ensure that the implementation is assessed for side effects 6) Ensure that a positive cost-benefit ratio. Koningsveld et al. (2005) added to these suggestions, based on their own experiences:

1. Take an inventory of the identified problems, risks, load, and other such information to help the committee move along
2. Use the most direct worker participation possible, meaning that organizational change and facilitating this participation are a priority
3. Attain a strong management commitment, as the implementations of solutions are approved at this level. Without management support, the group may perceive their work as useless and the PE program will not survive.
4. Use a step-by-step approach to ensure that expectations, goals, and timelines are understood so every member is aware of the process.
5. Use a broader focus then health problems to ensure that a multidisciplinary approach. Such factors as productivity may increase management commitment.
6. Have a responsible steering group to insure the project maintains momentum
7. Evaluate the effects, whether they are the direct effects of the project in a positive sense or unwanted side effects. Often this step is completed during a mock-up or prototype.

8. Identify the cost-benefit ratio that the full implementation of the project will yield. This should give management the ability to support the design or reject it.

Koningsveld et al. (2005) also suggested that this model will have increased chances for success if the ergonomist and steering group can identify the client's needs, relate the effects of the project in terms familiar to the client, and have skill in assessing cost-benefit information.

de Jong & Vink (2000) offered a simple five step framework for PE:

1. Participation – involves bringing together stakeholders to explain the aim of the project, the strategy, and set up a committee
2. Analysis of work and health – individuals involved with the work are asked for their input on the job tasks and health concerns
3. Selection of improvements – after identifying the risks, a solution is generated that is practical, cost effective, and has a health benefit
4. Pilot study – implement the solution in a scaled down from and test with normal production to ensure that the solution is of benefit
5. Implementation – after discussion on the outcomes of the pilot test the solution is moved to the implementation phase, if it fills the needs of the company.

In addition to these frameworks and models, other researchers have identified other factors that influence the success of PE. Nagamachi (1995) stated that the employees involved in the project must have the proper ergonomic knowledge and tools, as well as ensuring the project has a macroergonomic view to ensure that profitability and social change are involved in the intervention. St. Vincent et al. (1997) stated that professional status of the employees, prior training, and the social climate of the company can affect PE interventions. Vink, Koningsveld, & Molenbroek (2006) offered additional suggestions such as maintaining a good inventory of project parameters and describing the cost-benefit ratio in terms of monetary value rather than non-quantitative terms. In this way the company has a better understanding of the benefits. De Looze et al. (2003) suggested that having a good partnership between engineering and ergonomic professionals within a firm provides obvious benefits. In general, these suggestions are not offering alternatives to the principles found in the above frameworks but merely suggesting augmentation strategies to improve the process based on their experience.

The role of the ergonomist has been identified as an important factor in PE projects (de Looze et al., 2003; Haines et al., 2002). In PE projects, the ergonomist often has to take on a non-traditional role, when compared to traditional consultancy. The ergonomist acts as a facilitator to communicate between employees and management, oversee the training of employees, and other such duties that allow development of the program within the firm (Kuirubja & Patry, 1995; Carrivick et al., 2005). In some instances the ergonomist merely guides the seminars and the employees/ergonomics team assesses the risks, creates designs, and implements the solutions (Laitinen et al., 1998). In other cases the ergonomist is involved in all stages of the project, from training of the employees to implementing the new work design (Hess et al., 2004; Vink, 1995). Debate continues as to the role an ergonomist should assume in a PE intervention strategy. One can argue that given the small number of available ergonomic professionals the goal is to create an organizational system that can still function following the departure of the consulting ergonomist (Haims & Carayon, 1998). However, some reports suggest that, while trained employees are able to identify risks, their implementation strategies are sometimes not well designed or executed. For this reason, Wilson (1995) and Vink et al. (2006), among others, suggest that an ergonomics professional oversee the PE program at each stage to ensure that the design is practical and there is adherence to proper ergonomic principles. Perhaps the true role of an ergonomist is to facilitate and train the employees so that the program will continue on its own with reduced ergonomist contributions. After developing an in-house ergonomics capacity, the company can continue to deal with ergonomics issues, while occasionally consulting with the ergonomist to deal with complex issues and update training. This consultation arrangement can allow ergonomic improvements to continue within the company, without the financial burden of paying for a full consultancy each time issues are identified.

Beyond the role the ergonomist takes, an individual within the company who has influence can also aid the PE process. PE programs require significant organizational commitment at different levels of the company, and without it the program is unlikely to succeed (Laing et al., 2005). In instances where PE projects have been unsuccessful, project champions may have helped enhance project sustainability, particularly when the ergonomists are unable to have constant attendance at the site (Laing et al., 2005). Wilson (1995) also states that an internal project manager would increase support and sustainability of ergonomics projects. It seems this role has potential for significant impact on a project.

Although many of the models differ regarding the roles and requirements that must be taken for effective PE, there is some consistency among the reported factors:

1) Identifying the involvement of key personnel; developing a steering committee
2) Having a PE trained ergonomic facilitator
3) Having participation of employees from all levels of the organization in as direct a manner as possible
4) Having strong management commitment
5) Focusing on employees satisfaction, production factors and other such outcomes, not just health implications
6) Using a step-wise strategy for the project
7) Ensure that proper tools and equipment are available

To ensure that these factors are in place it appears that the ergonomist and key stakeholders have roles to play to maintain communication and exchange of knowledge. It is clear, therefore, that KT is a critical component of any PE intervention and success or failure of a PE intervention is often the result of underlying problems in KT.

2.4 Introduction to knowledge transfer

When studying KT there are several research perspectives that can be taken. KT as a cognitive research field involves the study of how an individual's knowledge is encoded in personal cognitive models, or schemas, and stored as a collection of entities in the mind of the learner (Boland et al., 2001; Tagliaventi & Matterelli, 2006). These mental models serve to influence the behavior of individuals and assist their decision making, based on the individual's experiences and personal philosophy (Boland et al., 2001). Although cognitive development and psychology of learning remain important research foci, these topics are outside the realm of research on organizational learning. Business, management and health-related KT research investigates knowledge exchange from a social and systemic perspective. This perspective on KT, as it pertains to industrial settings, involves understanding the content and context of knowledge and its process of exchange.

To evaluate KT from a social perspective one must also understand that KT involves more than one dimension. KT can occur at an individual, group, and organizational level within any firm or project (Argote et al., 2000). Consequently, the evaluation of how to attain and apply knowledge, as well as how to evaluate successful transfer, can differ depending on the scope of the investigation. Designating a project to have only one level of analysis is short-sighted.

The question is often "how is knowledge attained"? Knowledge is typically described in two distinct forms: explicit and tacit. Explicit knowledge refers to the knowledge that is readily available as codified information in the form of letters and numbers with an appropriate syntax to form such information as data, formulae, specifications, and manuals (Nonaka & Konno, 1998). Tacit knowledge represents the ideals, values, and emotions we gain from our personal experiences, thus making it difficult to articulate and formalize to others (Nonaka & Konno, 1998). Explicit knowledge is easy for individuals and organizations to exchange, while the exchange of tacit information is much more difficult. The codification and articulation of tacit knowledge would enhance the transfer of knowledge from one unit to another, however, tacit knowledge is connected to performance of a skill or thought pattern in an unknown way, making it is difficult to codify (Sherehiy & Karwowski, 2006). While, in the past, the western world has emphasized explicit knowledge over tacit knowledge, more recently the importance of tacit knowledge has been acknowledged (Nonaka & Konno, 1998). Organizations now recognize that much of the knowledge they possess sits in the minds of the employees rather than in databases (Sherehiy & Karwowski, 2006). Jashapara (2005) believes that the success of a project or company involves the management of these tacit elements. This view has led firms to view people, rather than technology, as their most valuable resource. The idea that the most important aspects of knowledge are tacit points to the difficulty associated with KT in any field.

Even if tacit knowledge is able to be articulated for the management and transfer of knowledge, the quality of the tacit knowledge represents another difficulty. For example, in order for individuals to have a full perspective they must have had a variety of experiences rather than a single monotonous experience (Nonaka, 1994). Also, if the individual is exposed to a variety of experiences, absorbing the information and internalizing new knowledge requires considerable skill (Nonaka, 1994). Socializing with other employees and working directly with the task ensures that the individuals enhance their experience by observing others, as well as developing their own cognitive patterns for the tasks. Attempting to enter into a KT project without satisfying these conditions would waste resources. For this reason, choosing only expert individuals to serve as knowledge donors for KT projects increases the chance that the individuals receiving the knowledge improve through the experience.

Given the factors associated with tacit knowledge the statements by Argote et al. (2000) regarding the difficulty of knowledge transfer are understandable. They report that 10 out of a total of 32 attempts at KT failed and were terminated, while the remaining attempts showed severe productivity loss and varying degrees of success. This is particularly important to PE interventions, as the knowledge required for intervention strategies involve skill acquisition and education, both highly tacit forms of knowledge. Investigating strategies and requirements to allow successful KT can help to eliminate potential difficulties.

2.5 Elements for success in knowledge transfer projects

Traditional knowledge transfer models focused on a linear process, where knowledge was moved from a donor to recipient, with mediation by translators (Parent et al., 2007). These models did not take into account contextual issues that can impact the KT process and did not describe the interactions between the donor and recipient of the knowledge. Nonaka (1994) states that the creation and transfer of knowledge requires a "*community of interaction*" among individuals involved in the project to allow identification, codification and exchange of tacit elements. The idea of social interaction is extended by Buchel & Raud (2002) who believe creation and transfer of knowledge requires the formation of a knowledge network. The design of the network affects the quality of the knowledge generated and exchanged, as networks that have a whole-organization view and sufficient managerial support allow development of best-practice strategies. Essentially, it is not enough to simply design an interaction between the holder of the knowledge and potential recipients, but rather the process must involve development and maintenance of communication lines between donor, recipient, managers and other stakeholders. Allowing network members, particularly the recipients of the knowledge, flexibility to gain knowledge during day-to-day operations of the company is also important; on-the-job training allows for more successful internalization of the knowledge and skills, as well as refinement based on personal and organizational needs (Nonaka & Konno, 1998).

Prior to developing a network strategy or partaking in a KT initiative, the firm must identify a need to partake in such a project. Organizational learning refers to a project director's ability to recognize current behaviors that lead to problems and reduced efficiency, and to their subsequent search for better techniques (Jashapara, 2005). If an organization has undergone an organizational learning process, has developed a strategy to implement new knowledge, and is actively seeking better methods, it will be actively *pulling* for new knowledge and programs (Lavis, 2006). Conversely, if the original holder of the knowledge engages in an attempt to find a suitable partner to transfer the knowledge to, this situation is commonly known as a *push* project (Lavis, 2006). Experience shows that pull efforts have greater success (Parent, 2006). Perhaps the reason is that, in pull efforts, the potential users already have a commitment to attaining new knowledge and are usually already willing to adapt procedures to allow the development of a network for KT (Lavis, 2006). Identifying a project as a push or pull initiative will identify whether additional motivation and support from the recipient company is required.

Key participants within an institution can have incredible influence over a KT project and its acceptance at the donor site. In a recent review, Thompson, Estabrooks, &

Degner (2006) attempted to clarify some key participant roles that exist in knowledge transfer projects and the resultant tasks these individuals must undertake for a successful transfer. Some of these roles include facilitators, champions, linking agents, and change agents. Facilitators require strong communication skills and have a concern for helping advance the support group in the project; they essentially work people towards the behavior change (Thompson et al., 2006). Facilitators are sometimes referred to as knowledge brokers, and are identified as having a critical role in OHS KT projects (Kramer & Cole, 2003). Champions advocate new ideas, projects, and products and help gain support and maintain momentum of the project (Thompson, Estabrooks, & Degner, 2006). Linking agents help to bridge the researcher-practitioner gap, while change agents ensure that the new behavior is implemented in the company (Thompson, Estabrooks, & Degner, 2006).

Of these roles, champions are considered to have a particular importance. Although the literature on the role of champions is limited, a review by Markham & Aiman-Smith (2001) attempted to investigate the role further. They state that a champion recognizes the potential of new technology, adopts the project as a personal interest, commits to the project, and attempts to generate support within the company. Champions work within the social-political structure of an organization to increase the chance of project success (Markham & Aiman-Smith, 2001). Although the project contains some risk, in terms of time and financial commitment, the champion has an underlying belief that the project will benefit them and their department (Markham & Aiman-Smith, 2001). A project may have more than one champion, and they can come from all levels of an organization, but the critical factor is that without champions projects are less likely to continue and/or succeed (Markham & Aiman-Smith, 2001). Champions were also identified by Kramer & Wells (2005) as having critical roles in the exchange of knowledge between OHS researchers and OHS professionals. In all, champions at a managerial level may help to maintain communication within PE projects and ensure that continued support and commitment within the company.

2.6 Models for networking and knowledge transfer in OHS and PE

The development of a social network to allow the transfer of knowledge forms the infrastructure and lines of communication required for KT. When using participative methods in OHS it appears that developing and maintaining the network is critical.

Kramer & Cole (2003) note that participative programs have the potential to improve working conditions but that there was a low implementation rate because of the inability to transfer the research knowledge to the workplace. Much of the work of Kramer & Cole, as well as of other members of their research team, involved implementing PE programs in Ontario, Canada, by creating a knowledge transfer program between researchers at the Institute of Work Health, health and safety professionals, and selected organizations (Kramer & Cole, 2003; Kramer & Wells, 2005). They based their work on a social interaction model that recognizes that personal interaction is the key to exchanging knowledge, with this interaction being categorized as either strong or weak (Kramer & Wells, 2005). Strong ties would involve more frequent and more intensive contact, and therefore would result in the greatest level of KT. Kramer & Cole (2003) suggest that the social construction and use of interactive group discussions were important to the project, leading them to emphasize the importance of interactive engagement. Kramer & Cole (2003) suggest that a KT process needs to be sustained and intensive to bridge the knowledge to application gap, while interactive engagements lead to effective communication; they assert the importance of having "*Intensive-Sustained-Interactive engagements*" for successful KT interventions in OHS.

Despite the valuable information gathered from their KT interventions, Kramer & Cole (2003) note they did not receive full cooperation from all parties involved in the interventions, including some management and union representatives. Safety is an ongoing interaction between managers, supervisors and employees in any firm (Kramer & Cole, 2003) and without buy-in from all levels a successful intervention is unlikely. Kramer & Wells (2005) investigated the process of building networks between stakeholders in a KT intervention to achieve buy-in. Although this project focused on moving knowledge from the Institute for Work Health to OHS professionals, the model provides insights into creating networks between knowledge sources and recipients. Their model outlines the progressive movement from establishing a dialogue and identifying areas where collaboration is possible, to disseminating and adapting the knowledge, and finally searching for further collaboration. Kramer & Wells (2005) found that establishing a network allowed the development of trust between the groups and a strong association that allowed for continue exchange of information. The development and maintenance of the network requires a facilitator (the researchers) to help the exchange between groups, and champions for each node of the project also aid the network (Kramer & Wells, 2005).

The work of Kramer & Wells (2005) and Kramer & Cole (2003) serves to demonstrate guidelines for successful OHS KT. Individuals involved in a KT process are the most important resource, however, one must also consider the movement of the knowledge itself within a network, not just the interactions between groups.

To investigate the movement of knowledge within a KT project, an investigation by Schulte, Lentz, Anderson, & Lamborg (2003) may have relevance. They attempted to map the movement of research knowledge on OHS and hygiene to the formation of policy. They used a model (Figure 2.1) built on the work of previous research in OHS and information science to describe the movement. The model moves from the creation of the knowledge and information within the scientific community, to the dissemination of this information after its publication, and onto the use of the knowledge at the worksite. Schulte et al. (2003) believe the process involves simultaneous interactions between the production, dissemination, and use of the knowledge rather than a linear flow, with each level affecting the others. This moves more towards a systems perspective that shows the different levels of interaction involved in OHS KT.

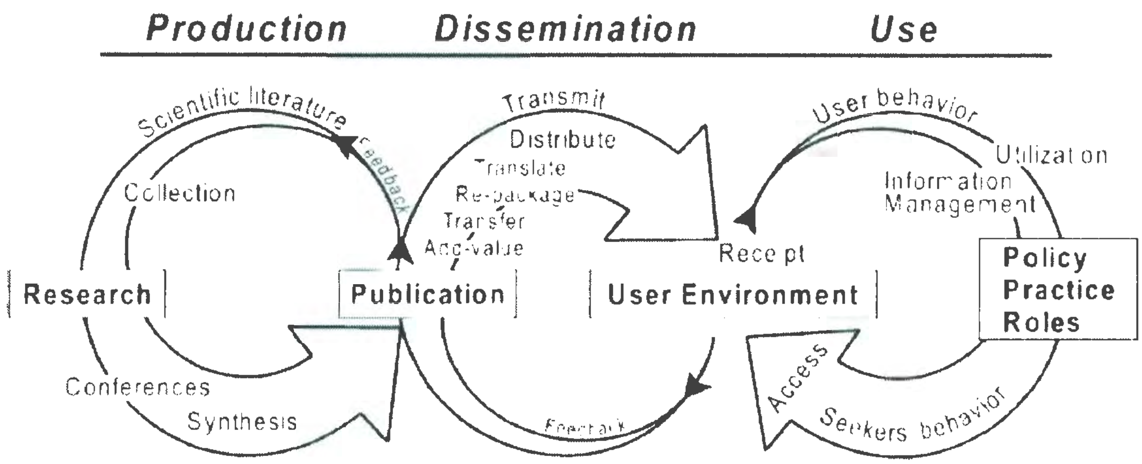


Figure 2.1: Schulte et al. (2003) model of information movement in OHS

This model is a reasonable representation of the movement of knowledge from its creation to use, but does not describe the role that individuals can play within the process. A model that accounts for knowledge, networking and human aspects would better explain the requirements for OHS KT.

A model described by Parent et al. (2007) may serve as the best representation of how social capacities and knowledge interact during KT. This Dynamic Knowledge Transfer Model (DKTM) was created, in part, by analyzing OHS KT projects. The model includes the existence of knowledge, the need for the knowledge, and four types of capacities that exist within a social system of KT: *generative*, *disseminative*, *absorptive*, and *adaptive and responsive* capacities (see figure 2.2). These capacities are contained within the idea that every system or organization has a knowledge base it possesses and a need for new knowledge. Generative capacity refers to the ability of individuals to create new ideas and knowledge which is practical and useful for application in real world environments. Within this capacity is also the idea that KT involves two-way transfer and the donors of the knowledge learn from the transfer to develop new knowledge. Disseminative capacity refers to the ability for knowledge to be articulated into understandable components, including the tacit components. Disseminative capacity is thought to be heavily influenced by the existence and type of social networks, knowledge brokers, and social and technological infrastructure that allow communication. Absorptive capacity refers to the ability of the recipient site to recognize the value of the knowledge, assimilate the knowledge, and apply it to the current practice. This capacity is rooted in the social environment of the recipient and its level of related knowledge, readiness for change, trust of the knowledge donor, commitment to adaptation, and management involvement. The final capacity involves the ability to adapt and respond to changes in the initial plan for knowledge transfer. Differences between organizational sites and unforeseen problems with industrial schedules, production, and availability of the individuals can impact the KT process. Therefore, the ability to cope with adjustments in each level from the generative to the absorptive level allows the transfer to continue.

The capacities can describe the knowledge held by ergonomics professionals, the ability to move that knowledge into understandable portions, and finally, the ability for end-users and participants in the PE process to absorb this knowledge.

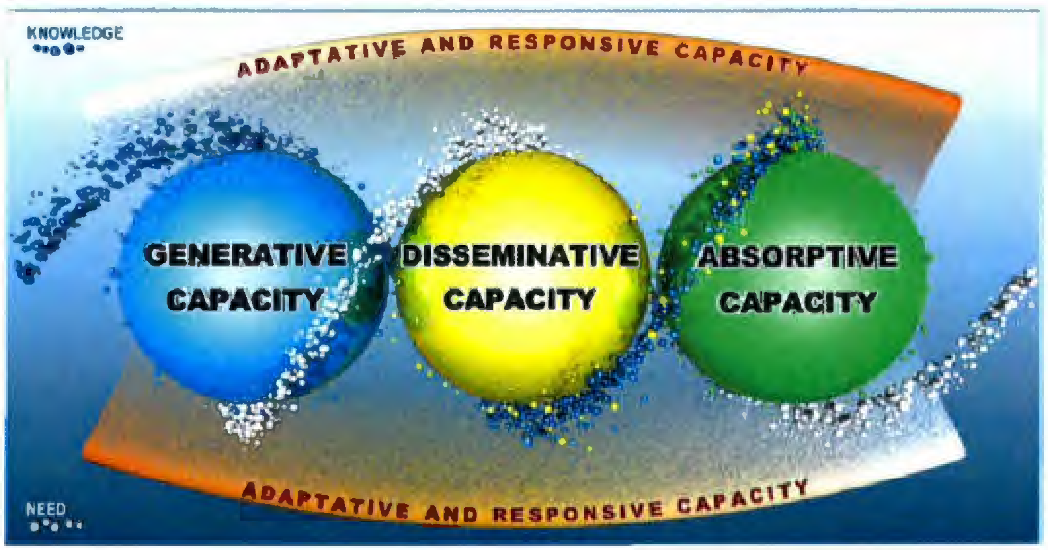


Figure 2.2: Parent et al. (2007) Dynamic Knowledge Transfer Model

This model shows a spiral of interaction between each of the levels in the system. Each capacity is dependent on the others for successful KT. Proper use of social interactions, ensuring proper content and context of the knowledge, and assigning required roles to the individuals involved in the transfer may help to overcome barriers to knowledge dissemination and absorption. Perhaps, investigating previously reported difficulties and barriers to KT can also help to identify potential problems that can impact on the DKTM's capacities.

2.7 Barriers to knowledge transfer

Knowledge transfer in health and PE is a relatively new discipline. The potential information on barriers to these projects and possible lessons is lacking, especially compared to the body of knowledge available in management and information science. The work of Berta & Baker (2004) supports integration of management based KT principles with health-related disciplines for the advancement of knowledge mobilization within the health professions. Therefore, reviewing difficulties encountered in other disciplines may offer analogous situations and lessons to adapt in participatory research in health and OHS.

Szulanski (1996, 2000) suggests that while KT is often seen as a dyadic exchange between two entities, the donor and the recipient, the process of transferring knowledge contains many moving parts at the level of the knowledge donor, the knowledge itself, and the recipient. Throughout management and communication research there are investigations into classifying the possible difficulties at these levels.

At the donor level, researchers often refuse to accept the responsibility of transferring the knowledge to practical application. Reasons for the refusal to share the knowledge can stem from the donor's belief that the knowledge is their own and they must protect the information to advance their own interests (Szulanski, 1996). These issues may impact the motivation of knowledge donors in OHS, as some of this information is often supplied by other industries and competitors, as well as researchers in a variety of fields. Other issues with the knowledge source involve the credibility of the group, individual, or organization. The recipient of the knowledge must perceive that the source is knowledgeable and reliable to ensure that the recipient commits to accepting the skill and behavioral change plan (Szulanski, 1996).

Much like the donors of knowledge, potential recipients of knowledge may also lack motivation to partake in transfer efforts. In the management literature, there are reports of organizations that tend to use only knowledge that was created intrafirm

(Szulanski, 1996). This can lead to a lack of buy-in from a recipient company, particularly within a KT push effort. Another widely cited problem at the recipient level is the lack of absorptive capacity (Szulanski, 1996; Dyer & Hatch, 2006). For various reasons, most likely stemming from content and contextual issues with the knowledge, the individuals attaining the knowledge are unable to grasp the necessary tacit and explicit components in a manner to master the skill or knowledge. Even with successful absorption of the knowledge, the longevity of the KT effort will be in doubt if there is a lack of retentive capacity (Szulanski, 1996). Content and contextual factors that have an impact on the absorption and retention of knowledge must be understood to fully appreciate how difficult KT can be.

An example of the impact knowledge content can have on KT is the idea of causal ambiguity. In the management literature the uncertainty associated with production routines and knowledge is given the term causal ambiguity. If knowledge is too specific to one type of organization, requires a high degree of complex interaction among systems or people, or has too many uncodified tacit elements, the amount of causal ambiguity is said to be high (Simonin, 1999). Similarly, if the language of the knowledge holders and recipients differs it can it can increase the difficulty in overcoming ambiguity and adapting knowledge (Simonin, 1999).

A concept related to ambiguity is the embeddedness of the knowledge that is intended for transfer. This term defines the sub-networks which make up the knowledge, including people, tools, and routines, and the need to activate each of these subunits (Cummings & Teng, 2003). The more elaborate the sub-networks, the more embedded the knowledge becomes, which may make KT more difficult. Tacit elements, ambiguity, and level of embedded knowledge all affect the ability to articulate and absorb knowledge.

Dyer & Hatch (2006) comment on the issue of the context of the knowledge impacting the transfer as much as knowledge content, knowledge donor, and knowledge recipient factors. Cummings & Teng (2003) review the relational, recipient, and activity contexts of the knowledge intended for transfer. Relational context refers to organizational distance, physical distance and knowledge distance. Organizational distance represents differences in the day-to-day operations and culture between companies, for example differences in production levels, size of the workforce and occupational health mandates. Physical distance refers to the geographical separation of the recipient and donor, and the subsequent impact the separation can have on KT. The knowledge distance between the donor and recipient represents the idea that the knowledge must be complex enough to foster the recipients' interest in absorbing it, but remain simple and practical enough for the recipient to understand it. Although physical distance was shown not to have a statistical effect in their investigation, Cummins & Teng (2003) did find that as organizational distance increased, transfers became more difficult, while knowledge distance had an inverted-u relationship; meaning that the success of the transfer depended on the knowledge being complex enough to foster interest in learning, but if it became too different from the donor's knowledge or too complex, transfer success decreased..

Although the relational context is important to the success of the project, the context in which the recipient of the knowledge intends to distribute and use the information is also important. Within the recipient context lie issues of project priority and learning culture (Cummings & Teng, 2003). Project priority refers to the importance the recipient places on the outcome of the project; a recipient who perceives the project as being high priority will have a greater inclination to offer support (Cummings & Teng, 2003). Learning culture refers to the recipient's willingness to designate responsibilities, tolerate creative mistakes during the transfer, and allow for greater downtime in normal procedures to ensure that those involved in the knowledge transfer fully absorb the information (Cummings & Teng, 2003). Cummings & Teng (2003) suggested that KT success may increase with higher project priority and improved learning culture on the part of the recipients.

The final type of knowledge context, the activity context, involves how the knowledge transfer will take place. This term specifically refers to the number and type of interactions and activities used during the transfer; some evidence suggests that the greater the number and variety of activities, the greater the success of the transfer (Cummings & Teng, 2003).

Looking at KT processes as a whole, Szulanski (1996, 2000) states that for KT to have complete success, the process must reach four successive stages: initiation, implementation, ramp-up, and integration. For the initiation phase to occur the recipients must identify their needs and find a suitable donor, the implementation phase requires the recipient to proceed with the intended project and alter production as needed, the ramp-up stage occurs after the knowledge exchange has occurred and the skills are first put into practice, and the integration stage refers to the acceptance of the new knowledge and skills into the everyday culture of the site (Szulanski, 1996, 2000). Problems with the knowledge itself, the exchange of the knowledge, motivation of the recipient, the learning culture, and other such issues can impact upon each of these stages.

Inevitably problems exist in any knowledge transfer initiative, as knowledge transfer is rarely an easy process (Szulanski, 1996). Ensuring the successful movement through each of the above stages is dependent on resolving the problems that exist through adaptive measures. In the Parent et al. (2007) model, adaptive capacity represents a critical component for the success of knowledge transfer. The ability to adapt learning strategies, equipment, and schedules in response to the unpredictability of the transfer, setting, donor and recipients is an important skill.

Jensen & Szulanski (2004) describe adaptation with regard to the application of the asset. They state that adaptation involves altering the assets being transferred to fit the environment in question, whether those assets represent information, skills, or technology. Jensen & Szulanski (2004) attempted to look at adaptive implementations during previously completed cross-border KT projects, where there were organizational and culture differences. The results revealed that in certain situations adaptation improved success of the transfer, while in others adaptation produced no benefits.. The authors reasoned that perhaps it is not enough to simply attempt to adapt the knowledge being transferred, but perhaps the timing of the adaptation is also important. It seems plausible that if adaptation takes place during the transfer itself, the original components of the knowledge may lose their meaning and context, thus compromising the success of the project (Jensen & Szulanski, 2004). The authors suggest first transferring the knowledge and skill as it stands and, once the transfer is complete, adapting the knowledge and skills as production processes dictate. In an OHS context, Kramer & Cole (2003) also comment on the role of adaptation. To adapt information, organizations required input from the workplace parties to combine the knowledge gained with their experience, ensuring a proper implementation strategy. These findings show that adaptive capacity involves exchange between the donor and recipient of the knowledge to adapt the information, learning strategy, and context as required. This process would require open communication between the parties involved.

2.8 Conclusion

Participatory ergonomics is thought to be an effective strategy to improve employee health and safety, productivity, and in some cases the OHS culture and ergonomics capacity at industrial sites. However, to date there is limited empirical and anecdotal evidence to suggest this approach is effective in a wide range of instances. Based on PE frameworks and barriers identified in PE literature, many of the problems that exist in PE interventions stem from KT issues. This literature suggests that addressing KT capacities may help to identify, and perhaps overcome, barriers which prevent a successful PE intervention. To date, very little research has been completed which examines both PE and KT factors that influence an intervention project, although further research could be relevant for future PE intervention models.

Chapter 3: Methodology

3.1 Development of the researcher's knowledge transfer network

The project that this thesis examines developed as a result of the work completed by the *Eastern Canada Consortium on Workplace Health and Safety*. Within Newfoundland, under the aegis of the Faculty of Medicine at Memorial University, a *Community Alliance for Marine and Coastal Workplace Health and Safety in Atlantic Canada*, known as *SafetyNet*, acts to conduct OHS research. SafetyNet had previously partnered with the IRSST in Québec, and *the Chaire d'etude en organisation du travail (CEOT)* at the Faculty of Business Administration at the University of Sherbrooke). The researchers who are members of the IRSST represented a valuable resource of knowledge for possible ergonomic and OHS interventions in this region, while the members of the CEOT are experts in the field of knowledge transfer and management.

This Consortium secured funding from the Interdisciplinary Capacity Enhancement (ICE) Program of CIHR to undertake research on workplace injury. Specifically, the undertakings of the Consortium would focus on facilitating the sharing of research results within Atlantic Canada, as well as between Québec and Atlantic Canada, while also developing new KT approaches for rural and small business settings. The objectives stated for the five years of funding were:

1. To add new, interdisciplinary, research and KT capacity related to workplace injury and permanent structures for ongoing capacity enhancement linking the participating organizations;
2. To build a network of research and community OHS collaborators in Atlantic Canada linked to the two Québec research organizations with their established social capital of community and institutional connections, thus creating a truly Eastern Canadian regional organization;
3. To enhance the capacity of researchers and decision makers in Atlantic Canada to work together more effectively in the field of WHS by transferring models and techniques developed in Québec

4. To combine the KT expertise of the two Québec partners with the emerging skills and partnerships of SafetyNet to develop methods for knowledge translation from researchers to industry and workplaces—methods specifically adapted to rural and remote locations, resource based industries and small enterprises;
5. To develop new, gender-informed methods for the analysis, prevention, treatment and rehabilitation of occupational accidents and illnesses, methods specifically designed for rural and remote locations;
6. To apply these methods to new problems and sectors, by developing collaborative pilot projects drawing on the skills and resources of Consortium members including many who will be newly recruited and/or retrained collaborators of SafetyNet, and by securing additional grant funding to pursue these projects;
7. To bring to English-speaking Canada a body of research results, methods and tools in WHS and KT largely unknown outside Québec, by translating and transferring the work of the IRSST and CEOT.

The Consortium undertook several projects that addressed these objectives, and these projects were intended to be 'quick hits'. The IRSST identified Dr. Nicole Vézina's 'train-the-trainer' Knife Sharpening Project as one such project for transfer to NL. Funding from the ICE grant and the WHSCC of NL set the foundation for the present investigation.

3.2 Description of the knife sharpening and steeling program

The KSP was developed through a research project in six pork slaughterhouses and processing plants in Québec. Working from accounts provided by 18 workers recognized as expert steelers and sharpeners, a consensus was reached by a research team based at the Université du Québec, and led by Dr. Nicole Vézina, concerning knife characteristics, tools, techniques, vocabulary and concepts (Vézina et al., 2000). A PE framework was employed to harvest the tacit knowledge regarding proper sharpening and steeling practices. The knowledge was validated by investigating ergonomic changes in work behavior and analysis of the blades using engineering and microscopy techniques.

The research resulted in the production of the *Manuel du formateur à l'affilage [Guide for Steeling Instructors]* and of a video entitled *Coupera ou coupera pas? [Will it or Won't it Cut? – later changed to Will it make the cut?]*. These teaching tools were field-validated by workers in several plants and form the basis of the teaching tools for a KSP.

In this program the ergonomist acts a facilitator, or knowledge broker, to bring plant management, OHS committee members, employees, and expert trainers together while also monitoring the program and making recommendations for program and workstation design. Meanwhile, selected individuals at the plant are given training with an expert trainer from another plant that had previously adopted the program. This allows the selected individuals to work to eventually become expert trainers themselves. Once trained, the employee-trainers then have the ability to machine-sharpen knives and then teach the steeling skills to other employees who use knives within the production area/company. In this manner, a representative participatory model is used to teach a small number of experts in one plant the proper sharpening, steeling, ergonomic, and teaching skills so that they can continue the program within the firm using direct participation of other workers.

The objectives of this thesis were to monitor the movement of knowledge between: 1) the QRT to the NRT, 2) the QRT and plant trainers, and later 3) to the plant trainers and deboning line employees. In the following section, the outline of the knowledge-to-action plan and the intended methodology for the project are presented.

3.3 Experimental design

SafetyNet acted as the facilitating research institute for the KT. SafetyNet's knowledge of provincial OHS culture, context and management, as well as having members who are involved in ergonomics, kinesiology, engineering, and management fields allowed them to act as a pivot point between the source and destinations of the knowledge.

Potential industrial partners were considered from local poultry and fish processing companies, as no industrial pork butcheries exist in the province. A partnership was established with a poultry processing plant in St. John's, NL. A St.

John's based industry was considered desirable because it allowed for easy access and regular onsite monitoring for the SafetyNet team based at the in that university located in that city. The poultry plant managers were given the opportunity to select the area where the KSP would be implemented and they chose the breast deboning area of the plant. This area is one of the only workstations in the plant that requires near constant use of knives and, although only a small number of employees work in this area, it represented the best site for the program's introduction at the plant. In the selection of this line, plant management requested that no information directly pertaining to pain prevalence and work-related health be collected during the project.

In order to establish the ergonomic KSP within NL, a successful transfer of knowledge to an in-province research institute (SafetyNet and the research team members) and to appropriate individuals at the plant from a Québec ergonomist/researcher and Québec knife experts (employees at a Québec-based plant) was required. The researchers from both Québec and Newfoundland (engineers, ergonomists, and knowledge transfer specialists) worked closely with plant management and the employees to form a tripartite partnership that would guide the knowledge adaptation, transfer and assimilation. This phase of the project would lay the foundation for SafetyNet and the NL trainers to work with future industrial partners on other OHS initiatives, specifically the second and third phases of the knife sharpening project (Figure 1.1).

The author of this thesis acted as a member of the NRT, where he was given a role in the facilitation of the program. Additionally, the author acted as the main observer of exchanges between the QRT, NRT and plant personnel with the intention of analyzing the information exchanged, barriers to communication and assessing the knowledge and skills transferred throughout the introduction of the program into the plant.

The KSP involved a "*train the trainer*" approach, by which, a Québec-based expert trainer conducted a series of workshops, demonstrations and on-site training with the intended trainer(s) for the new site. The expert helped the potential Newfoundland trainers improve their knowledge and skill through these interactions.

In this manner, the potential trainer(s) became directly involved in the program; they learned the principles of knife sharpening and steeling and how these principles are related to improved productivity and employee health. The plant's trainer(s) also helped to integrate the knowledge into the working operations at the plant after the required knowledge was transferred. Once the local expert trainer(s) became adequately skilled in three main areas they could train other employees in the basics of the KSP. The three skill areas the trainer(s) were required to develop were 1) sharpening 2) steeling and 3) teaching (presentation skills). The training of the employees required a theory session in a classroom and ongoing interaction with the trainer while on the production line. Figure 3.1 depicts how knowledge was moved between the different stakeholders in the project, and identifies the roles and responsibilities for each group.

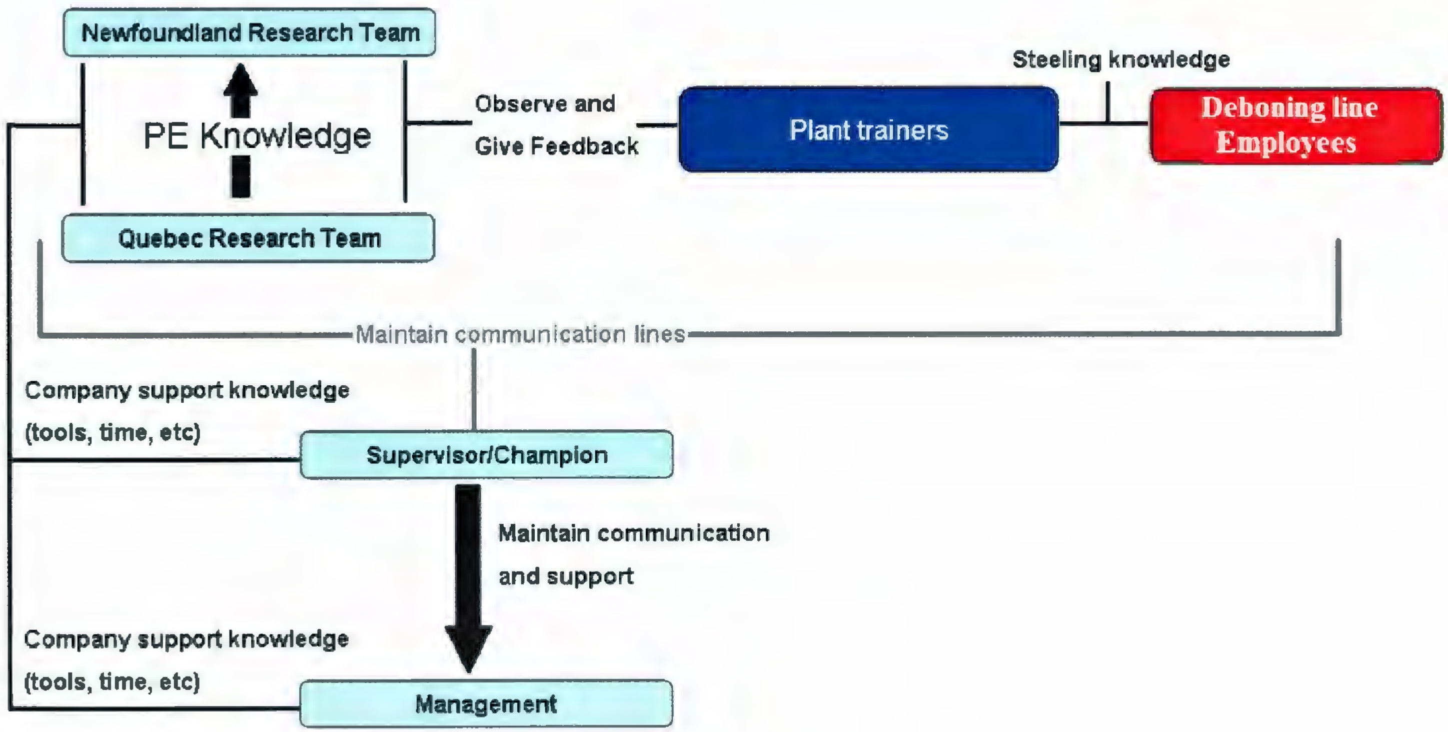


Figure 3.1: Intended roles and responsibilities for project stakeholders

3.4 Industrial partner and participants:

The project was approved by Memorial University of Newfoundland's Human Investigations Committee. The selected plant had existing issues with lost-time reports and absenteeism in several of its production departments. The deboning department was the focus of the project and this thesis. Its work consisted of removing defects from chicken breasts as they moved along a conveyer belt. Line workers used knives as the primary tool in their jobs, yet the employees had no formal training in knife sharpening, steeling, or care. Their habits of sharpening and steeling were based on tradition passed down from previous generations of employees, and knife care and storage was based on Canadian Food Inspection Agency (CFIA) and company policies.

In the initial stages of participant selection, the company provided three individuals to work with the project who would eventually become the first generation of knife sharpening and steeling experts in Newfoundland and Labrador. The company was free to nominate any individuals it desired and selected two employees from the deboning department who had earlier declared an interest in participating and met union seniority requirements. The plant was also made aware that they should select employees whom they believed to possess leadership skills. The third individual the company chose to become a trainer was the deboning line production supervisor, which would allow for management representation within the project. These individuals were asked to fill out an informed consent form. The participants were informed that all information would be kept confidential, that they must provide additional verbal consent at the time of any videotaping sessions, and that their skills would be assessed by the research team using a variety of evaluation tools.

The remaining employees of the deboning line were designated to receive training from the plant's trainers once they had successfully completed the "train-the-trainer" program. The deboning line consisted of both male and female employees. Six were permanent members of the deboning line throughout the duration of the project. Other deboning line personnel were often rotated to different tasks depending on production scheduling. Although these employees were not required to use knives on a daily basis, these 12 part-time line members were also asked to take part in the program and fill out the informed consent form described above.

The participants were all middle aged and they had all been employed at the company for a minimum of 3 years. There were no data recorded on age or experience level for any of the employee participants. This assured anonymity with respect to performance measures and comments collected from the employees during the project.

3.5 Procedure of the project:

Prior to beginning work with the poultry plant the NRT attained copies of the learning materials that were developed in Québec (*Manuel du formateur à l'affilage [Guide for Steeling Instructors*] and the video entitled *Coupera ou coupera pas? [Will it or Won't it Cut? – later changed to Will it make the cut?])* and had them translated into English by a third party translator. Although these tools had never been used for training in NL, their successful application in Québec provides an element of field validation.

The trainer who represented management (i.e., the production line supervisor) was intended to serve as the champion of the project. The champion's duties include sharing information between management and employees, maintaining project support, and ensuring training and practice times for the trainers.

The budget restraints of the project limited travel opportunity; therefore, not all members of the project were able to attend the initial familiarization session held in Montréal. The company was expected to send two of its trainers to attend a 2-day workshop in Montréal with an expert trainer from Québec. The company selected one of its deboning line employees and its management representative, leaving one employee-trainer at home. While attending the workshop, the two future trainers were introduced to the use of machinery for grinding, polishing, and buffing the blade, and shown evidence of the sharper cutting edge created using the machinery and the prescribed sharpening techniques. The two trainers were also introduced to the proper method of steeling a knife. Members of the NRT also attended the Montréal training session, were introduced to the facilitative process for participatory programs of this nature, and gained an understanding of the sequential learning that trainers require to develop the necessary skills.

Once the participants returned from Montréal, sharpening, polishing, and buffing machines were delivered to the company and were set up in a designated area of the plant. The trainers were then able to practice the skills they learned in Montréal with hopes of improving skills prior to the next training session with the Québec expert trainer, held in the St. John's plant,. This sharpening equipment belonged to the NRT and was to remain in the plants possession until the end of phase 1 of the project, when it was agreed that the company would then purchase its own similar equipment.

During the following week, a Québec researcher and expert trainer visited the Newfoundland based plant to begin the formal training of the selected trainers. This consisted of a classroom session with visual materials and manuals, printed in both French and English. The Québec trainer was unilingual French-speaking while the Newfoundland trainers were unilingual English-speaking. The Québec researcher facilitated the session and explained the development of the program, the results achieved in previous plants, and the ergonomic benefits of the program. In order to facilitate this interaction, a bilingual NRT member was required. Practical demonstrations by the expert trainer in the sharpening room and on the production line also served as training approaches. The company trainers were taught the proper way to steel a knife and asked to improve upon their skills during their work operations in the coming weeks and months. They were also given time to work with the Québec trainer on using the sharpening equipment, with where the Québec trainer offering tips, pointing out flaws, and helping with the acquisition of technical skills. The NRT, including the author of this thesis, observed the sessions to learn the processes required to 'train the trainers' and record the interactions for future analysis. In total, this series of training involved two consecutive days of six hour training sessions at the poultry plant.

The program intended that the potential trainers would practice regularly to improve their skills in sharpening and steeling. The intended plan for training and practice can be found in Appendix 1. After 3-4 weeks, the NRT videotaped the plant trainers' steeling skills while they were working on the production line. The taping period was intended to last for a total of 20 minutes per session. These video records facilitated an assessment of steeling skill for each trainer using a steeling analysis tool. Criteria for this assessment can be found in Appendix 2, which was translated from the QRT's tool by members of the QRT and NRT. Machine-sharpening skills were assessed by the expert trainer from Québec, as he held the expertise to critique the techniques.

The QRT instructed the NRT on how to analyze the video. The Québec ergonomist/researcher taught the Newfoundland researchers to use the steeling analysis tool to gather information from the tape. During each Newfoundland visit, the QRT continued working with the trainers on their sharpening and steeling skills. Initial work was also completed by the Québec trainer on teaching the company trainers to recognize flaws in sharpened and steeled knives and how to correct the steeling technique of production-line workers.

Over a period of three weeks the NRT began to work with the company trainers one day a week for 4 hours to go over the technical routine, the manuals, and the training principles they had received from the Québec trainer. At the same time the NRT also served to teach the trainers methods and skills for teaching and public presentation. The expert trainers were provided with basic background information on ergonomics to facilitate the identification and correction of operator-workstation interface problems.

The trainers prepared to teach the KSP to other employees at the plant. Mock training sessions, with members of the NRT acting as "participants", were staged as practice for the trainers. Following 6 weeks of preparation, a trainer delivered the knife steeling course to a group of production line employees.

Interruptions and other factors caused the project to be delayed for several months. These factors included: 1) employees taking vacation time, 2) increases in production during the summer months reduced the available time for training 3) movement of management personnel within the company, 4) one trainer had quit the program, while the other had taken a leave of absence taken from the company. These factors delayed the project for nearly 4 months, and interrupted the training of deboning employees.

The NRT videotaped the six employees who were daily users of knives and had been trained in proper steeling techniques. The taping lasted for 20 minutes at 1, 2, and 6 weeks post-training. These tapes were analyzed using the steeling analysis tool (see Appendix 2).

The research teams from Québec and Newfoundland met with management to discuss company support of the program at various times throughout the project. All meetings between the research teams, trainers, employees, and management were documented as part of a "learning history".

Questionnaires were distributed to members of the deboning line who had received the KSP training. The questionnaire consisted of two parts; one portion assessed some of the basic knowledge gained from the experience by means of a *Quiz on Steeling*, while the second portion gauged the participant's perceptions of: time constraints placed on them when attempting to learn the skill, equipment availability, company support, and continued program adherence (Appendix 3). A semi-structured interview was also conducted with 3 randomly selected employees of the 6 who consistently used knives on a day-to-day basis.

3.6 Assessment of the success of project objectives

3.6.1 Assessment of employees' working and knife steeling behaviors

A comparison of each individual's knife-steeling frequency, technical errors, and cutting frequency was completed following the collection each videotaped session. Positive changes in knife steeling frequency, reduction of technical errors, and cutting frequency across the each videotaping session indicated improvement in skill. The critical steps for proper steeling are detailed in Figure 3.2 and served as the basis for which technical skill was assessed. By observing the video, a count of the number of processed chicken pieces, the number of steelings, and the total time of the taping session was used to calculate values for the percentage of time spent on steeling, the average number of cuts between steeling, total number of cuts, and average rest-time between each cut. A sufficient amount of steeling frequency and a reasonably low number of cuts between steelings are recognized as important to maintaining blade sharpness. Assessment of changes in the total number of cuts and average rest-time between cuts over the 1, 2 and 6 weeks videos should indicate further changes in work behavior and possible improvements in mechanical exposure during cutting operations.

The Basic Principles of Steeling

1. Great concentration : visual attention, tactile perception, and coordination of movements.
2. The angle supporting the blade on the steel is the same as the angle of the bevel.
3. Watch the support angle of the blade.
4. The blade is supported on the steel without applying pressure. The steel is kept very stable.
5. While moving the knife, the angle and the pressure are kept constant.
6. The hand holds the knife lightly and the wrist is kept very straight.
7. The shoulder and the elbow make slow, easy movements.
8. The ends of the steel are avoided.
9. Alternate, passing the knife over the steel an even number of times on each side.
10. The knife and the steel are clean.

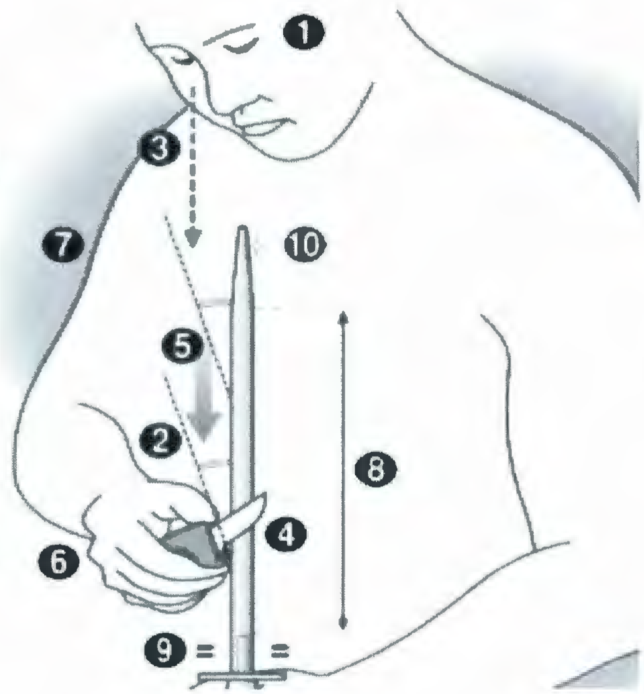


Figure 3.2: Principles of knife steeling

Chapter 4: Results

This chapter will outline the events contained in the project's field notes. In addition, the results of the *Quiz on Steeling* and assessment of changes in steeling skills, work behavior and work operations of the video recorded employees will be presented. Finally, the questionnaire on employee perceptions of the KSP and comments offered during the questionnaire and survey will be presented.

4.1 Factors that impacted on the KT process

Throughout the project there were significant events that impacted upon the development and progress of the PE KSP project. From the onset, it was expected that the original protocol employed in Québec could be followed in NL. Some notable events that required adjustments in the project protocol are presented in Table 4.1.

Table 4.1: Calendar of events

Month/Year	Events	Comments
November/ 2005	• Meeting at Poultry plant to introduce the project. WHSCC encourages the company to become involved.	• The project progresses as a research push, rather than a pull.
January/2006	• This marked the beginning of the project. • January 9th, 2006: Videotaping of trainers sharpening and steeling knives using traditional company method. • January 14th, 2006: One employee trainer and the supervisor trainer travel to Montréal for a workshop. • January 16th, 2006: The research project's sharpening equipment is taken to the company. • January 23rd-25th, 2006: Québec researcher and expert trainer make first visit to the province.	• Project momentum was generated for those who attended Montréal • Beginning of "train-the-trainer" approach with the visit from Québec expert. • Supervisor trainer is unable to attend the sessions in Newfoundland as a result of production commitments; intended to play the role of project champion. • Trainer who did not

		attend the Québec session expresses concerns over his exclusion.
February/2006	• Translated materials are refined. • February 9th, 2006: CFIA requires approval of a buffing paste used for the sharpening equipment. • Project is shut down pending approval of the paste by CFIA. • February 16th: Supervisor trainer is contacted to ensure that practice hours for employee trainers. • February 23rd: Reports of reduced training time for trainers as a result of production demand and lack of available replacement employees.	• The shutdown slowed momentum but did allow for improvement of technical terms in manuals and visual aids. • Company suggests practice time will be granted to the trainers according to production requirements and availability of additional employees.
March/2006	• Temporary approval of paste is granted by CFIA. • March 10th, 2006: Employee trainers are taped to assess changes in on-line steeling habits and sharpening skills. • March 12th, 2006: Québec researcher and expert trainer arrive. Assessment of steeling skills of trainers. • March 13th- March 15th: Expert trainer from Québec works with employee trainers at poultry plant. • Further translation and refinement of trainer's documents.	• Project begins to move forward once again. • First use of assessment tools for steeling technique; employees were expected to have been practicing the skills since the January session. • Second train-the trainer-session.
April/2006	• April 5th, 2006: Meeting at the plant with management to discuss progress. • April 8th, 2006: Second videotaping session of employee trainers. Trainers inform researcher they have not had time	• Management sees the project as moving according to their expectations, despite concerns from trainers and NRT. • Second use of steeling

	made available to practice. • Late April, 2006: Trainers attend several sessions with NL researchers on ergonomic principles and teaching skills.	assessment tool. • Begin to train the employee trainers in teaching skills.
May/2006	• Supervisor trainer is offered a promotion. • May 12th, 2006: NL researchers continue to work on teaching skills; one of the employee trainers drops out of program over public speaking concerns. • May 17th, 2006: Mock training course delivered by remaining trainer. • May 22nd, 2006: Québec expert arrives for refinement of sharpening and steeling skills of trainer. • May 25th, 2006: Trainer delivers first session to deboning line employees. • May 26th, 2006: First taping session of trained employee.	• Although he had little involvement, the current project champion was leaving the project within 2 months. • Continued development of 3rd aspect of trainer skills (teaching) • Project has only 1 trainer remaining. • The remaining trainer continues refinement of sharpening skills with the expert trainer.
June/2006	• June 8th, 2006: Meeting with plant management to discuss the project. • June 16th, 2006: Meeting with supervisor/champion about available practice times • Late June, 2006: No training completed; production schedule and shortage of available employees.	• Difficulty for company to find available practice time for sharpener/trainer and employees. • Project champion explains he was unaware of the depth of practice time required; unable to accommodate this need. • Production factors halt the project.
July/2006	• Trainer informs the NRT of lack of time available to sharpen • Use of stones for sharpening resumes, as company will not offer time to the sharpener to be away from the regular deboning line.	• No movement of the project on training; production schedules have left no available time for the sharpener to ensure that project requirements. • No properly sharpened

		blades on the deboning line.
August/2006	• August 1st, 2006: Trainer takes a leave of absence from work. • August 7th, 2006: Meeting with management; discuss required commitment to the project. • August 30th, 2006: Meeting with new line supervisor; previous champion has moved on. • August 30th, 2006: OHS coordinator at the plant is brought into the project.	• While the trainer is away, the project is put on hold. • Management commit to purchasing their own equipment, and a schedule of training. • New supervisor seems interested, but does not have a high status within the company. • OHS coordinator shows a strong interest in the project.
September/2006	• Trainer returns to work after his leave; Re-establish our partnership with him. • OHS coordinator takes a leadership role and creates a training schedule; line supervisor shows little support or understanding of the project. • September 17th, 2006: Employees are trained. • September 24th, 2006: Employees trained.	• Trainer reasserts his membership within the research team. • OHS coordinator takes role as project champion, although influence with plant's production lines is limited. • Training of the line employees begins again.
October/2006	• Employees trained each week in small groups throughout the month. • Contact with management to find an additional trainer for the company in case the current trainer became unavailable. • An individual is selected to become a trainer.	• Project is moving forward as intended. • A trainer to help the company with it's future sharpening and training, as well as additional knowledge source for NL industry is needed; an employee is selected to partake.
November/2006	• Videotaping of newly trained employees during work operations.	
December/2006	• Videotaping of newly trained	

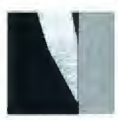
	employees during work operations.	
January/2006	• Additional trainer drops out of the program citing lack of company support regarding practice time. • January 29th -31st, 2006: Expert trainer arrives from Québec for final assessment of NL trainer's skills and offers assistance.	• The lack of communication between the new employee trainer and management seems to have led to confusion; subsequently the new trainer quit the project. • Expert trainer approves of NL trainer becoming the in-province expert, pending refinement of some additional sharpening techniques.
February/2006	• February 22nd, 2006: Quiz, survey, and interviews are conducted with employees who completed the program.	

The events documented in Table 4.1 often resulted in delays of meetings and breakdowns in the communication for the project. These events created barriers to communication amongst the QRT, the NRT, the plant's trainers, the supervisor/champion, the deboning line employees, and later the OHS coordinator/champion.

4.2 Quiz on steeling results

The *Quiz on Steeling* (Table 4.2) provides insight into the amount of technical knowledge the employees gained from the project. The total number of trained employees present on the day of the quiz was 18. The correct answer for each question is bolded or indicated in column 2 of Table 4.2.

Table 4.2: Results of the Quiz on Steeling

Question	Answers	Number (percentage) for each answer
1. The goal of steeling is to:	Get the cutting-edge back **Re-center the cutting edge** Remove the cutting edge	16 (88.9%) 2 (11.1%) 0 (0%)
2. Steeling requires what level of concentration?	Low Medium **High**	0 3 (16.7%) 15 (83.3%)
3. To steel effectively, it is recommended to strike the steel:	**Few Times** Many Times	16 (88.9%) 2 (11.1%)
4. To steel effectively, it is recommended to pass the knife on the steel:	Rapidly **Slowly**	0 (0%) 18 (100%)
5. While steeling, the pressure from the knife on the steel must be:	Strong Medium **Weak**	0 (0%) 0 (0%) 18 (100%)
6. Which technique will enable the knives to be steeled?	  **X** 	0 (0%) 14 (77.8 %) 4 (22.2 %)
7. Which joint (on the side of the hand holding the knife) should remain stable while steeling?	Shoulder Elbow **Wrist**	1 (5.5%) 3 (16.7%) 14 (77.8%)

The results of the *Quiz on Steeling* showed that at least 77% percent of respondents chose the right answer in every question except for Question 1. The fact that most people chose the wrong answer in question 1 may reflect poor question wording as a result of the French-to-English translation; the answer "to get the cutting edge back" was intended to mean that steeling would reform the cutting edge, but the statement may have been interpreted as meaning the same thing as "Re-centering" the cutting edge.

4.3 Analysis of work operations and steeling skills

Although the theoretical knowledge gained in the classroom setting is important, the true success of the KSP is to have employees apply the practical knowledge of steeling during work. The analysis of the work behavior and work operations for the 6 employees who were video recorded during production is used to assess the level of knowledge acquisition (see Table 4.3). Table 4.4 contains the information on errors in steeling skills for each employee during each taping session.

Table 4.3: Summary of steeling analysis during cutting tasks

Measurement periods	Subject	Total time of taping*	Percentage of time spent steeling	Number of steeling routines	Average number of cuts between steeling	Total cuts	Average rest-time between each cut
Week 1 Week 2 Week 6	EMP1 Male	20min 20min 19min12s	5.17% 4.75% 7.20%	8 7 9	29.9 35.8 27.4	250 228 252	4.8 s 5.3 s 4.6 s[X]
Week 1 Week 2 Week 6	EMP2 Female	20min 20min 16min56s	5.17% 4.04% 5.91%	6 5 8	40.4 40.5 37.1	231 214 275	5.2 s 5.3 s 3.7 s[X]
Week 1 Week 2 Week 6	EMP3 Male	20min 20min 20min	5.16% 8.16% 9.50%	8 7 7	29.9 32.7 25.2	250 240 180	4.8 s 5.0 s 6.7 s
Week 1 Week 2 Week 6	EMP4 Female	18min52s 19min11s 20min	9.36% 3.82% 6.40%	13 5 9	21.8 29.3 16.4	299 183 171	3.8 s 6.8 s 7.0 s
Week 1 Week 2 Week 6	EMP5 Female	15min59s 20min 20min10s	11.99% 5.58% 5.70%	9 6 6	33 59 80.4	309 361 381	3.1 s 3.8 s 3.2 s
Week 1 Week 2 Week 6	EMP6 Male	20min 20min 20min	10.50% 12.67% 9.42%	9 8 10	33.3 29.8 24.3	298 247 225	4.0 s 4.9 s 5.3 s

* Production schedules, fire alarms, line breakdown often forced videotaping time to vary from the intended 20minutes.

[X] The production line was shorthanded during this taping session.

Table 4.4: Assessment of steeling skills at 1, 2, and 6 weeks post-training

Employee	Week 1	Week 2	Week 6
1	Poor concentration; poor support of the blade from unstable wrist; steel position prevented vision of angles; did not clean the steel and knife before steeling; placed pressure on the blade	Improvement in wrist stability and control of movement; other issues remained a problem	All problems with the skill were corrected
2	Poor concentration; poor support of the blade from unstable wrist; movement was rapid and uncontrolled; did not clean the steel and knife before steeling	Improvement in wrist stability at the beginning of the motion; other issues remained	Wrist and blade stability at the beginning of the movement were improved; all other problems were still present.
3	Poor concentration; too tight of a grip on the knife; steel position prevented vision of angles; did not clean the knife and steel before steeling; placed pressure on the blade	All problems were corrected, aside from the pressure placed on the blade during steeling	All problems were corrected; some pressure on the blade during steeling
4	Inability to maintain a stable wrist; poor coordination of movement resulted inconsistent contact of the blade and steel	Increased stability and control; very tight and elevated shoulder, which can lead to injury problems	All problems with the skill were corrected
5	Unstable wrist in non-neutral posture; too tight of a grip on the knife; poor coordination of movement resulted in inconsistent contact of the blade and steel	The same problems existed	All problems with the skill were corrected
6	Poor steel position reduced visibility of blade angles on the steel; too tight grip of a grip on the knife	The same problems existed	All problems with the skill were corrected

4.4 Results of questionnaire distributed to trained employees

Employees' satisfaction with their role in the project is important. A survey was distributed to 18 trained employees to capture these data. The survey consisted of statements regarding the project and management involvement, assessment of the employee's own ability to perform the skills, and future application of the program (see Table 4.5).

Table 4.5: Questionnaire results

Statement	Answers	Number (percentage)
You were given enough time to use and practice the new steeling method over the recent months while at your workstation.	0 strongly disagreed 1 disagreed 2 agreed 3 strongly agreed	0 3 (16.7%) 14 (77.8%) 1 (5.5%)
Proper equipment and support were given after I was trained.	0 strongly disagreed 1 disagreed 2 agreed 3 strongly agreed	1 (5.5%) 3 (16.7%) 12 (66.7%) 2 (11.1%)
I could decide whether to be trained in the new technique or not.	0 strongly disagreed 1 disagreed 2 agreed 3 strongly agreed	0 0 17 (94.5%) 1 (5.5%)
Now that I have been trained I can decide whether to use the new technique or not.	0 strongly disagreed 1 disagreed 2 agreed 3 strongly agreed	0 1 (5.5%) 14 (77.8%) 3 (16.7%)
I feel I can have a say in whether or how the new technique will be used in this plant in the future	0 strongly disagreed 1 disagreed 2 agreed 3 strongly agreed	0 2 (11.1%) 14 (77.8%) 2 (11.1%)
The new sharpening and steeling techniques can benefit other areas of the plant and should be	0 strongly disagreed 1 disagreed 2 agreed 3 strongly agreed	0 0 14 (77.8%) 4 (22.2%)

implemented as soon as possible.		
I am confident that employees and the company will continue to use the sharpening and steeling skills in day-to-day operation long after the research project has ended.	0 strongly disagreed 1 disagreed 2 agreed 3 strongly agreed	0 3 (16.7%) 15 (84.3%) 0

The employees were asked about their ability to use steeling to maintain the quality of their cutting edge and about their satisfaction with the training (see Table 4.6).

Table 4.6: Employee assessment of steeling ability and satisfaction with the program

Statement	**Answers**	**Number (percentage)**
You are able to properly follow the cutting edge of your knife while steeling:	0 never 1 rarely 2 from time to time 3 most of the time 4 always	0 0 3 (16.7%) 10 (66%) 5 (27.8%)
Are you satisfied with the training you received?	0 not at all satisfied 1 partly satisfied 2 satisfied 3 very satisfied	0 1 (5.5%) 12 (66.7) 5 (27.8%)

The final question asked the employee to assign a numeric value on a continuous scale from 1 to 100 for their satisfaction level with the sharpness of their blade both before and after the training program. The 18 employees reported an average satisfaction level of 51.7 (SD:13.93) before the training and an average value of 86.7 (13.28) after the training.

4.5 Trained employees` comments on the program

Several employees also provided written comments on the surveys. Some of these comments relate to the positive results on the survey, while others identify potential underlying issues that were not captured directly in the survey. Some respondents made positive remarks regarding the time and effort put into the program by the trainer and the research groups, while others voiced some concerns about the support offered during training. The following are some of the comments received in the 18 surveys:

Concerns on enough time to practice the new skills:

> *"The fast work pace was a factor in not having time available to practice."*
>
> *"Work is too fast paced."*

Meanwhile, other employees felt the program was a benefit for them:

> *"I think the knife sharpening course was very beneficial to the debone area and highly recommend it to the rest of the plant. I feel confident in what I was shown and thank you for your time"*

Some employees commented on the work done by the expert trainer:

> *"I feel that everything was explained to the fullest by [the trainer]"*
>
> *"[the trainer] did a good job."*
>
> *"Support was positive, enough information to properly steel a knife."*

In addition to the comments made by the employees during the survey, the 3 employees randomly selected to take part in an exit interview also offered comments. Many of these comments revolved around how they were trained, support and praise for the work being done by the trainer at the plant, and their satisfaction with the program. There were comments concerning equipment and support, in terms of available knives and steels, and access to training time with the plant's trainer.

Each of the three interviewed trainees was asked to identify what he or she believed to be a critical step in steeling. One stated he believed that maintaining a proper frequency of knife steeling was the most important factor for his work, while another believed awareness of the angle of the blade and steel was most important. The third interviewed trainee made an interesting comment: he believed that having the company providing personalized steels and knives to each worker was the most important factor. At that time, the company had not put individualized steels and knives into practice. Each worker also explained how the training program had altered their steeling method from the traditional approach and how each of them, through practice, had refined the technique to fit his or her own needs.

Each one of the trainees interviewed believed the program was beneficial:

"*It makes the job easier*"– Employee 1
"*You have a sharper blade, wrist is less sore, there is less strain on the arm, and there are better cuts.*" – Employee 3
"*We have better cut quality, more efficient work, and reduced effort of work.*" – Employee 6

In terms of what they thought made the program successful and improved their satisfaction with their blades they mentioned:

"*Having a proper sharpener and proper equipment improved the sharpness of the blade*" – Employee 3
"*Using the training makes the knife stay sharp longer*" – Employee 6

The trainees noted the program and training had positive impacts on their work despite some difficulty, particularly while they were learning the skill.

"*It is much easier to cut the chicken*" – Employee 1
"*It is easier on the wrist, the blades stay sharp longer, but we must steel more often*" – Employee 3
"*The training slowed down my workpace at first, but once I got used to it I had better and quicker cuts. It is easier on my arm and shoulder*" Employee 6

Two of the three candidates noted that the tools provided by the company could have enhanced the program:

"*A better quality of knife, more available knives between sharpening, and a better quality of steel would be my suggestion.*"- Employee 3
"*Personalized knives and steels would allow better control over your blade and improve the program.*" – Employee 6

Chapter 5: Discussion

The objectives of this thesis were: 1) to study the factors that impacted upon the transfer of the KSP from a Québec Research Team (QRT) to the Newfoundland Research Team (NRT) and a poultry plant, 2) to evaluate the impact of the KSP on employee work behavior and productivity and, 3) to attempt to identify the impact that a KT strategy has within a participatory ergonomics (PE) intervention. Evaluation of these objectives occurred during the first phase of the KSP included as part of the Consortium's CIHR-ICE grant (see Figure 1.1). This phase involved building a base of PE knowledge and capacity to mobilize knowledge within the NRT, with the goal of having the NRT transfer the KSP 'train-the-trainer' program in future plants. While evaluating the first phase of the KSP is useful in identifying whether the NRT had gained the required knowledge and experience, perhaps a more important outcome during phase 1 of the project is the identification of factors that influence KT conditions within PE projects. Identifying these factors (see Table 4.1) and how they relate to KT capacities can provide a clearer understanding of the PE process and, in the future, improve the NRT's ability to transfer knowledge.

5.1 Evaluating generative capacity

Knowledge transfer in projects of this nature involves two-way learning. Knowledge donors often gain knowledge related to the delivery of the knowledge to the recipient (Parent et al., 2007). In the present project there is little measurable evidence to suggest new knowledge was created, but there are anecdotal reports of knowledge generation.

In terms of knowledge related to the KSP 'train-the-trainer' process, the QRT gained new knowledge. Until undertaking this project the QRT had only delivered this program in French, primarily in pork processing plants. Through this project, the QRT learned that they could successfully use bi-lingual translators to mediate 'train-the-trainer' sessions to train other researchers in a facilitative role, and develop new trainers at a plant. The QRT also developed knowledge regarding adaptations that must occur to run the KSP at a poultry plant. They also gained insight into how to run these projects in smaller enterprises, as opposed to the large pork plants they had used to develop the program. The challenge of small numbers of available employees and the limited availability of training time and equipment at the NL plant resulted in a revision of the the delivery of the program by the QRT.

The NL plant trainer also worked to generate new knowledge after he had received the basic knowledge from the Québec expert. He was able to take the original materials and information offered to him by the QRT and refined it to develop in-plant manuals on proper knife steeling, and develop a process and procedure for training that fits the needs of the NL poultry plant. This plant was also able to apply what they had learned about proper knife and steel storage principles into the design of a storage unit to be used on the production floor. Until this design was proposed to the plant, they did not have any type of storage system, resulting in poor tool maintenance and performance quality.

The NRT were also able to generate new knowledge. The PE and KT knowledge was institutionalized to create learning materials for students and other researchers. These materials can be used to train additional PE facilitators in the future. Clearly, this was a principle objective of this research activity.

5.2 Evaluating communication networks and disseminative capacity

Disseminative capacity requires a networked communication strategy to facilitate the breakdown of knowledge into its constituent elements. In a PE research approach, the social infrastructure required for dissemination of knowledge involves the establishment, support and maintenance of communication lines. Failure to maintain two-way or networked communications negatively affected the present project and often resulted in delays and impeded progress.

In this project there were 3 primary groups of actors that were required to communicate: the QRT, the NRT, and the plant personnel directly involved in the KSP activities (the plant's trainers, and the deboning line supervisor). Aside from these three groups, plant managers were required to communicate with those involved at various levels of the project (see Figure 5.1).

5.2.1 Communications between Québec and Newfoundland & Labrador teams

The NRT reviewed the scientific, ergonomic, and administrative tasks required for the project. They also observed the facilitative activities of the QRT during their visits to the NL plant. This improved their understanding of the roles and requirements for an ergonomist/research team in a PE 'train-the-trainer' project. However, there were some problems with the exchange of information and communication between the two groups, resulting in slower knowledge dissemination than originally anticipated in the project's timeline.

When exchanging knowledge between two different cultures, language can present a barrier. Differences in primary language resulted in more lengthy, disconnected exchanges between the research teams. The training materials used for the project required translation, and this work was completed by an outside party. There can be a loss of context for certain terms and phrases during the translation process. Unless the individual completing the translation has experience with the PE program's context and technical terminology related to knife sharpening and steeling, translation may become inexact. As a result, ambiguous terms were an unavoidable by-product of the translation process. Subsequent meetings between members of the research teams identified ambiguous terms and phrases, and corrections to the training materials were made. For example, the term used to describe the edge of a knife, which in reality can only be viewed through a microscope, was translated as *the wire edge*. To the English speaking individuals a *wire edge* describes the microscopic edge as having imperfections that reduce its sharpness, but prior to the translation the term described the fine, malleable, edge of a knife that performs the cuts. The term created confusion for the researchers and trainers, and the term to describe the microscopic edge was adjusted to be *the cutting edge* of a knife. Figure 5.2 demonstrates the English speaking individual's idea of a *wire edge* and *cutting edge* for the English speaking individuals. Perhaps the barriers in communication as a result of language could have been overcome with more frequent interaction between the teams, but given the physical distance between the two provinces and limited funds for travel, this was not a practical solution.

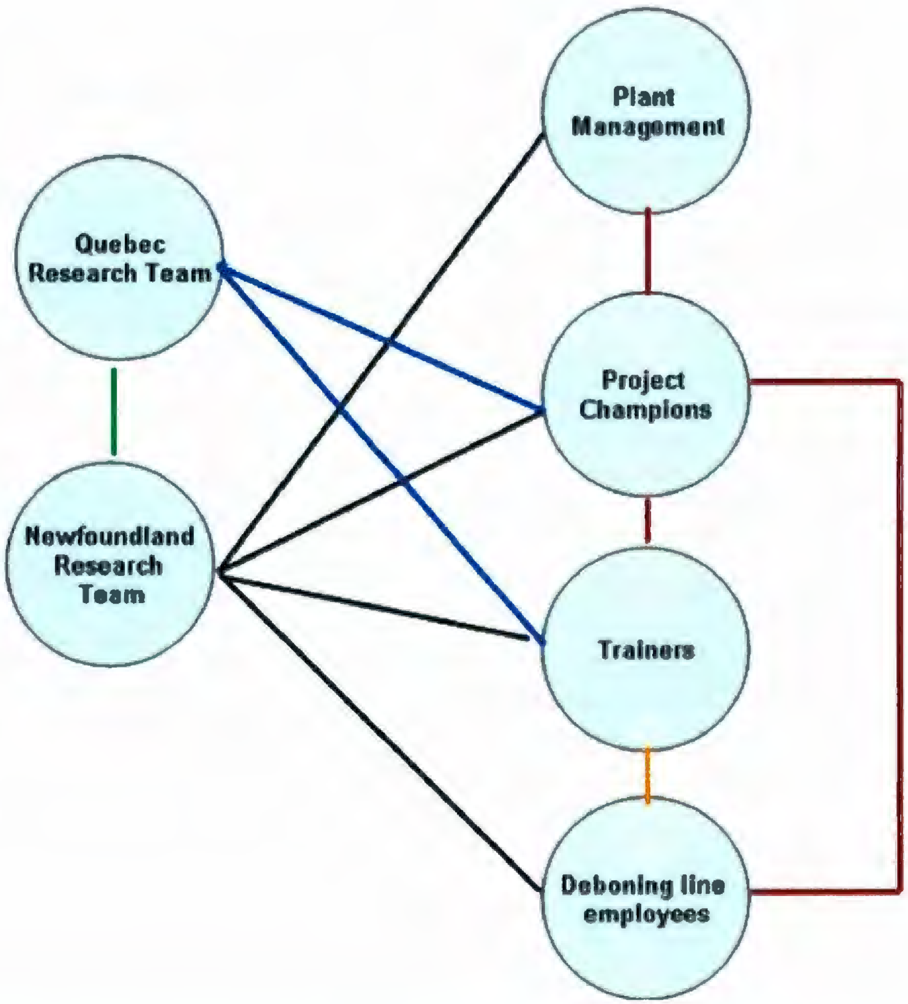


Figure 5.1: Lines of communication between project stakeholders

A *wire edge* of a knife

The sharp *cutting edge* of a knife

Figure 5.2: Microscopic view of the "wire" cutting edge of a "dull" and "sharp" knife

Another barrier to communication was the delay in meetings between the NRT and QRT as a result of project shut-down pending the approval of a buffing paste used for the machine-sharpening process (see Table 4.1).

The limited experience of the QRT in conducting inter-provincial PE KSP transfers also impacted negatively on the disseminative capacity. The QRT had previously only transferred this program to food-processing plants within Québec. In the present project the QRT were required to transfer the program knowledge to a group of researchers, with little experience in this work, in another province. The QRT had a field tested strategy to move the sharpening and steeling skills to plant employees, but they did not possess a previously developed strategy did to move the PE KSP knowledge to a group of researchers. Therefore, the QRT lacked the required program infrastructure to promote the dissemination of this form of KSP knowledge.

5.2.2 Communications of the between the QRT and plant personnel

The project relied heavily on having the plant's trainers interact with the QRT to gain the required explicit and tacit knowledge for sharpening and steeling. Communications between the QRT and the plant's key personnel were impacted by language barriers. Neither the expert trainer with the QRT nor the Newfoundland trainers were bilingual. The dissemination of explicit knowledge was complicated by the need to translate the learning materials from French to English. Additionally, the translation of knowledge between the expert trainer from Québec and the Newfoundland trainer required mediation by an interpreter/translator. This exchange of communications between sharpeners is critical to the ongoing codification of tacit knowledge and the generation of new knowledge. It was this tacit knowledge that jumpstarted the whole train-the-trainer program in Québec, and the advancement of the program in NL is dependent on this NL trainers internalizing this tacit knowledge. The flow of the tacit knowledge would have been impossible without a translator who: 1) was able to communicate effectively in both languages, and 2) understood the day-to-day goals and operations of the project. The interpreter was a member of the NRT, which ensure that he had an understanding of the project objectives, allowing him to articulate ideas in both languages, without losing context. Although the interpreter was able to move knowledge between the QRT and plant trainers, mediating conversations through an interpreter resulted in lengthier exchanges. The time required to exchange knowledge often created time constraints for the QRT and trainers to meet all of the outlined objectives during their meetings. More frequent interactions might have helped improve communication and knowledge dissemination between the plant personnel and the QRT.

The QRT also attempted to inform the project champion, as a representative of the plant's management structure, of the levels of support the plant trainers required in terms of practice time and equipment purchase and the release of line workers from their duties to undergo training. Unfortunately, the physical distance between them prevented frequent enough interaction between the champion and the QRT to build a network of communication that would allow the champion to understand the critical importance of the advice offered by the QRT.

5.2.3 Communication between the NRT and plant personnel

Between visits of the QRT, the NRT was required to maintain contact with the plant to ensure that the project was moving forward. Communication between the NRT and the plant personnel was required to coordinate the KSP activities, and increase the knowledge base in ergonomics and the teaching/presentation skills of the NL expert trainer.

The NRT's lack of understanding of the importance of forming a networked communication strategy with the plant trainers resulted in the trainers misunderstanding their duties; one of the trainers quit the program citing an inability to balance the training requirements with his supervisory tasks, while another quit the program due to his unwillingness to undertake a public-speaking role during training. The NRTs were also unaware of the importance of fostering managerial buy-in for the program, and working towards maintaining consistent communications with management. As a result, the NRT were not successful in fostering a functioning network among managers, trainer and employees within the plant.

Maintaining communication with upper plant management was also difficult to develop without a managerial participation in the day-to-day project activities. In theory, the managerial project champion would have helped with establishing and maintaining communication with upper management, but the champion did not give the project sufficient priority. It seems plausible that the communication medium selected for interaction with management may also have negatively impacted on the disseminative capacity. Using email as a primary administrative tool to coordinate with the industrial partner was a mistake, as they did not appear to use this technology on a regular basis. Offering information to plant management through email was also a problem because the flow of communication did not reach employees, as line employees do not have company email accounts. During the evaluation of the project the NRT was required to evaluate the PE KSP by gathering information from deboning line employees. Without a previously established mode of communication between the employees and the NRT, the knowledge exchange was difficult to coordinate and obtain.

The plant's OHS coordinator emerged as a new project champion and served as the mediator for communication between the research teams, the trainer, and management. Exchanges between project stakeholders were improved with this individual as the project champion.

5.2.4 Communication between the plant personnel

The initial project champion and plant trainer had limited interaction in the project. This resulted in the trainer having difficulty ensuring adequate time to practice sharpening knives and implement a suitable knife storage system. He had difficulty promoting his ideas to management. Once the OHS coordinator had taken over the role of project champion, the information she offered to the champion was conveyed to management in a more consistent and timely fashion. Unfortunately, unlike the production line supervisor, the OHS coordinator did not have authority over production and scheduling procedures. This was necessary to maintain the project's momentum. The lack of communication between managers, the champions and the trainer resulted in the line employees having little knowledge of the project's scope, timelines and training schedules. Lines of communication between the trainer and deboning line employees were negatively impacted by the inconsistent on-the-line training time.

5.3 The impact of project events and factors on absorptive capacity

Communication barriers undoubtedly affected disseminative capacity and undermined the KT effort. The content of the knowledge, the nature of the interaction between the donor and recipient, and the organizational culture of the recipient site create the situational context of the transfer; this context can subsequently affect the ability to exchange knowledge, particularly at the absorptive capacity level (Szulanski, 1996; Parent, 2006).

The KSP involved exchange of skills and personal routines for sharpening and steeling skills. This knowledge is highly technical in nature, which can make its absorption more difficult. More frequent interactions between the QRT and the trainer, and between the trainer and the employees would have helped the recipients absorb and codify the tacit portion of the knowledge. Results from the *Quiz on Steeling* (Table 4.2) suggest there were some employees who did not understand the requirements for proper steeling. Additionally there were 2 employees who were unable to change work behavior to one that satisfies the KSP program. It is interesting to note that the two individuals who were unable to gain, or at least apply, the skills were women. Learning the practical steeling skills requires very close interaction and contact between the trainer and trainees; perhaps there was a gender issue which biased the trainer-trainee relationship.

The development of the partnership between the research teams and the plant may also have affected the KT process. The WHSCC of NL was a funding source for the KSP and, from the outset, identified potential industrial sites where the program would be of use. The poultry plant may have felt an obligation to take part in the program because it had been identified by the WHSCC. Perhaps the organization itself had not recognized, or felt the need to correct, the problem. Without recognizing the need for organizational learning the company is unlikely to have successful KT (Jashapara, 2005), as management were not actively *pulling* for the knowledge. This left the project as a research *push*, which typically leads to decreased absorption of new knowledge.

Motivation of the donors and recipients of the knowledge can impact upon absorptive capacity (Szulanski, 1996). During this project the motivation of the original knowledge donor (QRT) is unlikely to have created problems. As researchers, the QRT motivation is to increase the availability of their research so that it reaches a wider audience. At the recipient level, poor motivation issues could have affected four groups: 1) the NRT; 2) the plant management; 3) the plant trainer; and 4) the deboning line employees.

The NRT had sufficient motivation to learn because this project has direct benefit to their research program and offered improvement to their capacity to perform OHS and ergonomic interventions. Given the approval garnered by the plant's trainer from peer-employees and the QRT it appears he absorbed the pertinent knowledge. The improvement in his skills throughout the project may suggest that this individual was motivated to take part in the project and possessed the aptitude to perform sharpening, steeling and training. The trainer also served as a project champion at the employee level, constantly trying to increase the amount of buy-in and attempting to gain support at management levels. Positive comments and adherence to the program by many of the trained employees also suggest this group had motivation to learn the skills and employ them in their daily practices.

Cummings & Teng (2003) identify several items that, when embedded in the organizational culture and routines, can have a negative impact on the absorptive capacity of a network. Organizational distance refers to differences between the donor site and recipient site in terms of everyday production activities and culture (Cumming & Teng, 2003). The type and amount of meat cut, as well as the size of the workforce, represent differences between the Québec and NL plants. As a result of lower production and fewer employees in the NL plant it was more difficult to: 1) have replacement employees to allow continued training of deboning line employees, 2) maintain consistent daily production to allow timely adaptation and integration of the KSP into standard operating procedures. In Québec, the program was designed to allow delivery of the theory portion of the project in a classroom with continued practical training on the production line over the following weeks. Often, this training was done under reduced work-pace situations. These organizational realities limited the time available for learning during production at the Newfoundland plant. This increased the difficulty of the knowledge uptake by the employees.

Cummings & Teng (2003) point to learning culture as a factor that can affect the situational context of the KT. Learning culture denotes the willingness to designate responsibility, tolerate creative mistakes, and allow greater downtime in operations to accommodate the introduction of new knowledge into the system (Cummings & Teng, 2003). Without consistent managerial involvement it was difficult to develop, or adjust, the plant's learning culture in a time-efficient manner, and this, in turn, produced barriers at the absorptive level.

Some of the factors noted by Cummings & Teng (2003) to facilitate KT were present for the KSP at the poultry plant. For example, knowledge distance refers to difficulty and relevance of the new knowledge to the donor; if it is too difficult, or not relevant enough, transfer success decreases (Cummings & Teng, 2003). This program involved a novel approach to OHS and ergonomic interventions for the Newfoundland researchers and was practical enough to fit the profile of industries in Newfoundland. Similarly, at the industrial level, the way of preparing and steeling knives was drastically different from previous practice, making the knowledge novel but still relevant enough to influence employees to learn.

5.4 Overcoming barriers to disseminative and absorptive capacity

Communication barriers and the day-to-day culture at the company impacted on the KT. In the Dynamic Knowledge Transfer Model (Parent et al., 2007), the knowledge is thought to flow through the system's generative, disseminative and absorptive capacities, and problems, obstacles, blockages, barriers at any of these level can impede the movement of knowledge. The adaptive and responsive capacity represents the ability for project stakeholders to identify these barriers and attempt to take corrective measures (Parent et al., 2007). Sufficient adaptive and responsive capacity is important to the success of any KT.

In the present project the adaptive and responsive capacity is represented in the ability of the research teams to adjust their timelines during prolonged disruptions to the protocol. Additionally, the ability of the plant's trainer to adapt the presentation materials to best suit his teaching style and the needs of his fellow employees also allowed progress in the KT process. The trained employees showed adaptive and responsive ability as they adapted the skill and frequency of steeling to fit their needs at the workstation and production demands. The QRT had also considered the proper timing for adaptation of the knowledge. The QRT did not attempt to adjust the sharpening, steeling or training skills to meet the needs of the poultry plant until after the plant trainers had learned the skills and knowledge using the same training sequence proven successful in Québec. Transferring knowledge in this manner ensure that none of the embedded elements of the knowledge was lost before the recipient site had gained it (Jensen & Szulanski, 2004).

The insights gained from this project will improve future transfers of the KSP. There are steps that were taken in the present investigation that should be repeated during similar transfers, while there are other steps that require adjustment. A positive step that should be repeated in a similar cross-language project is the use of the same translator for all face-to-face interaction between the groups. By spending time with the project and its members, this translator came to understand the context and the terminology of the project and was able to accurately articulate ideas in both languages. The use of a previously field tested program was also important to the success of the program. In this manner, a defined strategy of learning and communication was in place at the outset of the project, which promoted the establishment of social infrastructure for knowledge dissemination. However, in future cross-language transfers, steps should be taken to adjust the content of the program to prevent the loss of context for translated terms and phrases.

In future projects, a clear communication strategy should be established at the very outset between all groups partaking in the project. This should include strategies on how to communicate information to line employees, establishing a necessary social network. From the outset of the project, establishing a fixed schedule of training and meeting dates for the program will help to maintain momentum. Having clearly defined roles for all those involved in the project will help the knowledge dissemination process. For example, the champion must have a vested interest in the project and must help to remove barriers and to maintain the support of managers.

In terms of absorptive capacity, the use of a continuous learning strategy in which the trainers develop their skills over time by working with the expert trainer and research team is the most efficient strategy to help apprentice trainers internalize the required knowledge. However, improvement in the management of timelines to increase the quality of interactions, maintain project momentum, and foster employee buy-in would also help to improve the absorption of the knowledge. Assessing whether the company is ready to accept changes to its operation and outlining these possible changes can help to overcome barriers stemming from organizational distance. In turn, this may help to refine and improve the learning culture at the plant, and facilitate the adjustment of day-to-day plant operation.

5.5 Evaluation of the participatory ergonomics intervention at the poultry plant:

To evaluate the success of any ergonomics intervention it is important to consider the changes that occur in physical, psychological and organizational factors (Theberge et al., 2006). The long term success of the intervention also requires adaptation of social, organizational and industrial factors (Kuorinka, 1997). In the present study, video analysis data, questionnaires and interviews were used to gauge the effectiveness of the KSP intervention in terms of physical and psychosocial factors, while the longevity of the program can be determined by assessing the level of involvement of key stakeholders.

5.5.1 Evaluation of physical exposure

The results of the video analysis data for the 6 deboning line trimmers (Table 4.3 & 4.4) indicate whether the KSP has had a positive effect on physical exposure levels. Based on previous studies (Szabo et al., 2001; Vézina et al., 2000), successful adherence to the proper steeling principles should reduce required muscular force to perform cutting operations and reduce the number of required cuts for the work task. Vézina et al. (2000) suggested that steeling during pork processing should take up to 11% of working time. While poultry meat is much softer than pork, the idea that steeling should constitute a substantial percentage of work cycle should still hold true. Improvement in cutting operations would require a reduction in the number of cuts between each steeling, which should improve the quality of the blade and result in decreased number of required cuts per shift, and an increased amount of available rest-time.

Employee 1 was able to improve his technical skills by the sixth week after struggling with some of the required principles in the initial two weeks. He also increased his percentage of time spent steeling his knife, and decreased the average number of cuts made between each steeling. During his final taping session, the production line was shorthanded, which increased his workload. Therefore, it is difficult to determine whether his improved steeling skills had actually decreased his level of physical exposure during work tasks. The number of cuts made in the sixth week is approximately the same as in the initial session. This may suggest that, given the increased workload, his blade was more efficient at making cuts. However, some caution in assessing this individual is needed as a result of confounding production factors.

Employee 2 did improve the control of her wrist and stability of the knife by week 6, but did not exhibit high levels of concentration on the steeling task and did not clean her knife and steel prior to steeling. Her steeling frequency marginally increased from the initial taping session, and although the average number of cuts made between each steeling did decrease, it remains fairly high at 37.1 cuts/steeling. Her improvements in technical ability were not sufficient to properly perform the steeling skills and, given that her average rest-time between each cut decreased, it appears no change in work-behavior or reduction in physical exposure has occurred.

Employee 3 was able to satisfy all technical requirements to complete the steeling skill by the sixth week, aside from placing too much pressure on the blade during some steeling attempts. The employee also improved his steeling frequency, lowered his average number of cuts between steeling to 25.2 cuts/steeling, lowered his total number of cuts, and increased the available rest-time between each cut. The increased skill and frequency of steeling appears to have lowered his physical exposure during cutting operations.

Employee 4 also improved her skill in steeling by the sixth week. She was then able to control the knife and move in a coordinated manner, ensuring proper contact between the blade and the steel. Although her steeling frequency dropped from week 1 to week 6 from 9.36% to 6.40%, it seems that this percentage may be high enough for her work task, especially considering she has dropped her average number of cuts between steeling from 21.8 to 16.4 cuts/steeling. She also reduced her total number of cuts made during the taping session by 100 total cuts, and improved her average rest-time between each cut.

Employee 5 was able to improve her technical ability to steel a knife by the sixth week. She was able to eliminate all her errors and perform the skill with controlled and coordinated movement. However, her steeling-time dropped by a large amount from the first week, and her average number of cuts between each steeling increased to 80.4 cuts/steeling by the sixth week. Despite her improvement in steeling skill, her inability to perform the task regularly prevented improvements in blade quality. Comparison of the total number of cuts is difficult as a result of a fire drill during one of the taping sessions, and changes in production time during the taping sessions. However, her average amount of rest-time between each cut remained approximately the same. This employee does not appear to have benefited from the program, at least not at the present time.

Employee 6 had the ability to perform the technical components of the steeling task from the outset and by the sixth week he had made an adjustment in steel position that improved his ability to see the angle of the blade on the steel. His steeling percentage did decrease from 11.99% to 9.42%, but at the same time his average number of cuts between steeling decreased from 33.3 cuts/steeling to 24.3 cuts/steeling. The reduced total number of cuts and increase in average rest-time between each cut from 4.0 to 5.3 seconds suggests that his changes in steeling frequency and cuts between steeling, along with refinement of technical skill, reduced his physical exposure during cutting operations.

From the six videotaped employees (Table 4.3 & 4.4) we can conclude that employees 3, 4, and 6 gained the required knowledge and skills required to properly steel and knife. As a result, they showed a reduction in physical risk factors. Employee 1 also improved his skills, and began to show signs of being able to reduce his workload by week 2. The added workload of a short-handed work-line resulted in little change in the physical exposure by the sixth week. However, given the improvement in technical ability, steeling frequency and average number of cuts between each steeling it appears that this employee also benefited from the program. The remaining two employees did not seem to be as successful in adopting proper steeling habits. Employee 2 did not successfully attain all the required technical skills, and Employee 5, despite having most of the technical ability by the sixth week, did not steel her knife with sufficient frequency. Although the company did not want the research teams to collect any direct measures of health, it can be assumed that, based on previous studies, the changes in cutting tasks decrease the risk of musculoskeletal injury for a majority of the subjects.

It is interesting to note that the 2 individuals who were unable to learn and/or apply the skills at the time of evaluation were female. However, given that the small sample size drawn for the video recording analyses, any discussion regarding gender effect can only be speculative.

5.5.2 Evaluation of psychosocial factors

Gauging the feeling of employees regarding the KSP program represents another important component to evaluating the success of the intervention at the poultry plant. The survey that was distributed provided insights on this issue (Table 4.6 & 4.7)

Evaluating the statement *"I could decide whether to be trained in the new technique or not"* probed whether felt they had a choice to get involved in the program. On this question, 17 of the 18 employees choose "Agree", while the remaining employee selected "Strongly Agree" as his/her answer. This would suggest that employees felt they were involved in the program and given a choice regarding their involvement. The statement *"Now that I have been trained I can decide whether to use the new technique or not"* was used to determine whether the employees felt they had a choice in how to use the KSP program or whether they were being pushed into it by management or the research group. 17 of the employees selected "Agree" or "Strongly Agree" for this statement, while the remaining employee selected "Disagree". It appears that, for the most part, the employees felt that they could choose whether or not to use the program. The statement *"I feel I can have a say in whether or how the new technique will be used in this plant in the future"* was used to determine if employees felt they would have a continuing role in the project in the future. In this case 16 of the 18 employees selected "Agree" or "Strongly Agree". At the poultry plant, it seems that the employees feel the program will continue in the plant after the research project has concluded. Having sufficient involvement of employees is an important factor in improving employee satisfaction; without this involvement the improvement in the quality of the work life may be less than expected, especially when the program moves out of the hands of the research group and fully into the plant's hands. From the statements above it appears the involvement of workers in the KSP was sufficient to lead to improvements in employee satisfaction.

Many authors have noted the importance of management support for a project (Koningsveld et al., 2005; Maciel, 1998; Kramer & Cole, 2003). The statement in the questionnaire "*You were given enough time to use and practice the new steeling method over the recent months while at your workstation*" assesses the employee's perception of the time and support management gave them during the learning phase. 15 of the 18 employees selected "Agree" or "Strongly Agree" for this statement. The statement "*Proper equipment and support were given after I was trained*" assessed the employee perception regarding equipment and access to the trainer's advice. 14 of the 18 employees selected 'Agree' or 'Strongly Agree'. It appears that the majority of employees perceived management to have offered sufficient support during the training. This finding is somewhat surprising considering that management was often reluctant to allow employees time to practice during production hours. Despite the support the surveys indicate, several comments indicate practice time was an issue that affected the learning process, which relates to managements inability to make required adjustments in their operation:

"*The fast work pace was a factor in not having time available to practice*",

"*Work is too fast paced.*"

Kuorinka (1997) noted that PE approaches require adaptation of social, organizational, and industrial elements within an organization. During this project, there was little accommodation by the company in terms of production and industrial procedures, which may have led to the lack of available practice time. Obviously, it is difficult for any company to change its production schedule, but perhaps adjustments would have been more forthcoming if management had been more engaged in the program and its expected outcomes.

The perceptions of employees regarding satisfaction with their role and the support offered by management are important factors, but they must also be satisfied with the training process and the concomitant outcomes. Comments offered in the survey included:

> *"I feel that everything was explained to the fullest by [the trainer]"*, and *"[the trainer] did a good job"*
>
> *"I think the knife sharpening course was very beneficial to the debone area and highly recommend it to the rest of the plant. I feel confident in what I was shown and thank you for your time"*
>
> *"Support was positive, enough information to properly steel a knife"*.

These responses indicate that the plant's trainer offered his support when needed and the employees were satisfied with what they were taught. The scores on employees' satisfaction with the sharpness of their blades before and after training indicate some level of improvement. On average, the 18 employees indicated a value of 51.7 out of 100 for their blade satisfaction level prior to training, and a value of 86.7 after the training. Additionally, 17 of 18 employees chose 'satisfied' or 'very satisfied' regarding training satisfaction. The remaining employee selected 'partially satisfied'. The fact that no individual choose 'not satisfied' may indicate a successful training program. The surveyed and interviewed employees also identified the benefits to the work process and use of the knives:

> *"It makes the job easier"*
>
> *"You have a sharper blade, wrist is less sore, there is less strain on the arm, and there are better cuts."*
>
> *"We have better cut quality, more efficient work, and reduced effort of work."*

However, concerns were raised over the lack of available tools and equipment. Two of the interviewed employees indicated some dissatisfaction with the availability of additional knives and steels. The QRT had identified the need for individual knives and steels for all employees of the deboning line in order to improve the internalization of skills. Management was not supportive of changing their policy regarding the release of tools to employees, and did not understand the importance of this element to the success of the KSP.

The long-term impact of this project was to create an in-house knife sharpening and steeling strategy which the company could continue to use long after the researchers were no longer directly involved. This is why a participative ergonomics intervention approach was selected. Carrivick et al. (2005) and St. Vincent et al. (1997) have noted that ergonomics and OHS are disciplines that are much too small to have enough professionals to handle all the problems in every organization, especially on a day-to-day basis. This is why a PE approach tries to place ergonomics knowledge within the organization. The statement "*I am confident that employees and the company will continue to use the sharpening and steeling skills in day-to-day operation long after the research project has ended*" was used to address the potential for the continued use of this project in the plant. 15 employees selected 'Agree', indicating the employees supported the continuation of the program at the plant. Although employees see potential for the continued use of the program in this and other areas of the plant, management would have to increase their role and knowledge base to ensure that the sustainability of the program. Furthermore, continued use of this program should lead to improvements in the process and overall increases in organizational learning and knowledge improvements

5.6 Knowledge transfer factors in the KSP

The KSP intervention at the poultry plant can be considered a success based on apparent reductions in physical exposure, and positive comments noted by employees in terms of satisfaction with the program. However, the program was not universally successful in that 2 of the 6 employees studied in detail (Tables 4.3 & 4.4) were unable apply the KSP skills to benefit their work operations. Table 4.2 suggests that despite the majority of employees scoring very well on the *Quiz on Steeling*, there remained trained employees who do not understand or could not retain the steeling principles.

Additionally, tool availability and practice time remained issues with the project, and managerial representation in the project was limited. After the NRT had ended their involvement at the plant, managers had not gained the knowledge to facilitate the program during future sessions, which suggests limited improvement in OHS and ergonomics capacity for the organization as a whole in the future.

Another major issue with the KSP was the length of time required to conduct the intervention. The future success of this program, and other PE projects, is to ensure that the intervention is conducted as scheduled to prevent wasted personnel and financial resources.

There are several critical factors for success for a PE intervention:

1. Identifying the involvement of key personnel; forming a steering group
2. Having a PE trained ergonomic facilitator
3. Having participation of employees from all levels of the organization in as direct a manner as possible
4. Having strong management commitment
5. Focusing on employees satisfaction, production factors and other such outcomes, not just health implications
6. Using a step-wise strategy for the project
7. Ensure that proper tools and equipment are available

Of these factors, the KSP seems to have accounted for items 3, 5, 6, which are likely to have contributed heavily to the successful portions of the project. In this project, employees from the deboning line were directly involved in the training process and were informed on the purpose of the intervention; the level of direct participation is likely to have contributed to the employee satisfaction with the program (Laitinen et al., 1998). The nature of the employee involvement, for both the trainer and employees, was also a facilitative element. As Kramer & Cole (2003) noted, there is a need for sustained, intensive and frequent interactions in PE & KT projects, which was possible when one-on-one interactions with the trainer and trainees occurred. PE literature also highlights the importance of a stepwise and progressive learning style (de Looze, 2001; Koningsveld et al., 2005); the use of an established and field-tested program created by Vézina et al. (2000) ensures that a progressive and stepwise approach to learning and implementing the project was in place.

The remaining four PE requirements (1, 2, 4 and 7) were not present during the KSP. The NRT were responsible for day-to-day interaction with the poultry plant, as the QRT were only in the province for short periods of the time. The NRT's inability to perform as a facilitative ergonomist, at least in the earlier stages of the project, resulted in their inability to properly identify roles for key management personnel, and the NRT were unable to foster buy-in at a managerial level. This resulted in insufficient managerial commitment, and difficulty in securing proper tools, support and practice time. The inability for the NRT to perform the role of a facilitative ergonomist and identify key personnel in the initial stages of the project was also a function of barriers to communication with the QRT. The interruption of meetings, the physical separation between the QRT and NRT, and the lack of a previously defined strategy to transfer PE KSP knowledge negatively impacted on the dissemination of knowledge from the QRT to the NRT.

Another reason for the inability to gain sufficient managerial involvement stems from barriers at the disseminative and absorptive capacity levels. If the NRT had been able to outline a communication strategy with management and develop a management-employee steering group to oversee the project at the plant, perhaps the roles and responsibilities of for key stakeholders would have been better disseminated. In addition, the project was a researcher *push*, and the organizational culture of the company was not ready for a PE intervention; thus reducing absorptive capacity. The managers' inability to adjust the organizational culture prevented them from absorbing the required knowledge regarding their role in the project.

The noted barriers in disseminative and absorptive capacity also limited the ability of plant personnel to understand the need for proper tools and support. Without knowledge of the need for personalization of tools, and the need for continued on-the-line training, no adaptation in policy or production procedures occurred to ensure that this PE requirement was met.

From these observations it seems KT and PE elements are related in projects of this nature. By evaluating them together a more defined picture of the intervention process can be developed and, in the future, steps and strategies to facilitate KT can enhance the impact of PE interventions.

5.7 Limitations of the project:

The present project served to help the research team gain a great deal of knowledge and insight into the PE and KT processes. However, industrial and logistical limitations created difficulty in gathering a wide range of data, and impacted on the time taken to collect the data.

At the outset of the partnership with the poultry plant the management requested that no measures of health, qualitative or quantitative, be used during the experiment. As a result, little information could be gained from the plant in terms of direct impact on employee perceptions of health, reduction in muscular effort, or actual reduction in cutting forces. Had these measures been attainable perhaps more concrete evidence for a reduction in physical risk factors could have been gathered in this experiment, while also giving the PE project an element of quantitative analysis.

The present project, like many case study approaches to PE research, may be criticized for the lack of a randomized controlled design and of quantitative measures. These are valid concerns, but authors such as Straker et al. (2004) suggest that it is difficult to employ randomized controlled designs in industrial settings as a result of logistical issues, organizational change, and uncertainty. Additionally, Hess et al. (2004) talked of the environment, production, building site, management philosophy, and time constraints associated with industrial work and how it can reduce the ability to accurately assess physical measures. One may argue that the use of case studies and field work to gauge the effectiveness of PE remains a valid experimental approach. The information gained using these methodological approaches likely has greater ecological validity and allows better 'real-world' assessment of intervention frameworks.

The introduction of extraneous work factors while videotaping employees was also a problem. It is highly likely that these individuals changed their working and steeling behaviors from normal practice while their activities were being monitored. Additionally, the availability of only 6 full time employees for video recordings makes it difficult to draw conclusive evidence for changes in work behavior and gender effect. However, this evidence can be strengthened by applying the information gained in this thesis to results of future, more extensive, KSP and PE studies.

Finally, this project served as a learning experience for the NRT. They were expected to learn from the QRT and to begin to develop their own capacity to undertake PE interventions. Unfortunately, this lack of initial experience impacted negatively on the development of communication lines between researchers and plant personnel. Although this was an unavoidable consequence of the project's design, the implementation of the KSP was affected by the NRT's concurrent goal of learning the PE and 'train-the-trainer' process.

5.8 Conclusions

This project has laid the foundation to develop a capacity to implement PE interventions within NL. Meanwhile, development and understanding of KT paradigms for both the QRT and NRT have added to their understanding of what does and does not work in a 'train-the-trainer' program. Analysis of the system's generative, disseminative and absorptive capacities identified strategies to improve the delivery of the program in future plants.

Interpreting the success of the KT depends on whether the focus is on the individual, group, or organizational levels (Argote et al., 2000). The movement of knowledge to the NRT was successful at a group level, as the NRT and its members gained considerable exposure to PE frameworks and 'train-the-trainer' programs. At an organizational level further steps are required to ensure that the longevity of the KSP.

There is currently only one KSP expert trainer in the province and SafetyNet must ensure that other individuals in the province continue to be trained as experts. This will help to institutionalize the knowledge and skills within the province.

At the poultry plant, there is evidence to suggest that many of the individual employees of the deboning line have successfully gained the knowledge. At a group level, however, it appears that there are differences in knowledge uptake and/or retention between employees. At an organizational level, the KT effort was not fully realized as company managers were not fully immersed in the KT, resulting in incomplete institutionalization of the knowledge at the plant. It seems that at the poultry plant the project was a partial success. The KSP knowledge is held by the trainer and employees of the deboning line, but without managers having knowledge of the KSP, the long term institutionalization of the program is unlikely.

Although previous knife sharpening studies have focused on improvements of working conditions for line employees, further phases of the NL KSP should include an analysis of the improvements in working conditions for the trainer/sharpener as well. The traditional method of sharpening a blade on a stone involves a high level of muscular exertion, and may subsequently lead to work-related injuries. The use of a machine grinder and improving in-house steeling skills will: 1) reduce the effort and time to sharpen blades, and 2) reduce the frequency of blade sharpening and should provide health benefits to the trainer.

The DKTM (Parent et al., 2007) identifies KT factors and how they impact on KT within a PE project. Identifying barriers to networked communication, dissemination of knowledge and absorption of knowledge related well to PE requirements identified as missing in this project. Learning from these barriers and planning for them in future interventions should improve knowledge movement in PE interventions. However, using KT models purely as a diagnostic tool to evaluate project successes is short-sighted. Applying KT models into the methods of a PE intervention would likely result in more successful outcomes.

Defining PE frameworks to include KT strategies further highlights the interdisciplinary nature of ergonomic interventions. Interventions must include the application of scientific principles, as well as application of social science to effectively move knowledge to action. In future research, there is a need to further investigate the role KT plays in PE projects to define more effective PE intervention strategies.

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Appendix 1: Intended plan for training and practice

Leader	First visit to plant (Only NL Team): <u>October 13th – Half Day</u> 1. Introductory meeting of local team (NV by teleconference) with plant management and safety/ergonomics committee.				
-----		Time devoted to task by <u>each</u> Future Trainer, while in contact with team (hours)			
-----		In class	On floor, interrupted	On floor, normal work	Knives to collect (total)
	1.1 Communication of objectives and steps in the project. Agreement concluded on study and course. Explanation of criteria for the choice of future trainers. The plant must supply a room, referred to in the following as "class" or "class room," for some training activities and meetings away from the plant floor. Other activities occur on the production floor, referred to as the "floor," at relevant work stations. At times this will involve the future trainers at their usual work at their usual pace; at other times there will be interaction with them so that they will not be working at their usual pace The assistance and involvement of the principal management staff (H&S coordinator, production manager, supervisors, etc) is important. Some management personnel should be present at some sessions with future trainers, in particular during the first visit of the Quebec members to the plant. 1.2 Review of the facilities and procedures for the sharpening of knives at the company.				

-----	2. Collection of data on productivity and safety before course: Prior to January 5th			
	2.1 Company provides incidence data, and data on material input, product output, person-hours for relevant work areas in plant.				

Leader	**Second visit to plant (Only NL Team): January 5th, 1 Day** **3. Initial analysis of the steeling techniques of the future trainers by the NL ergonomist(s)**				
-----		**Time devoted to task by each Future Trainer while in contact with team (hours)**			
-----		**In class**	**On floor, interrupted**	**On floor, normal work**	**Knives to collect (total)**
	3.1 Individual interviews, in class with each of the future trainers on their professional experience, their steeling techniques and the particular demands on them in their work. Videotaping of the steeling technique of each future trainer in class while he explains it during the interview.	2i			
	3.2 Videotaping of each future trainer at his normal work on the floor, without interrupting his work.			1	
	3.3 Videotaping of normal knife sharpening (by sharpener who does sharpening for all workers, or by each worker if he sharpens own knife)			1	

	3.4 Collection of a sharpened knife (if sharpened by single sharpener) 3.5 Collection of a knife steeled by each future trainer (whether sharpened by that worker or by another worker). 3.6 Compilation of results on each future trainer in a file for that person.				1 3
-----	**4. Preparation for the course by the expert trainer and NV:** **<u>Week of January 9th, 3 days</u>**				
	4.1 Evaluation at MUN and UQAM of the knives prepared by each future trainer Analysis of the individual files by NV and expert trainer in Montreal 4.2 One future trainer views knife sharpening and training by expert trainer in Montreal plant.	One worker spends **3 days in Montreal**			

Leader	**Third visit to plant (NL Team & Nicole Vézina):** **<u>Week of January 23rd, 2 Consecutive Days</u>** **5. Instruction in sharpening and steeling for the future trainers**				
-----		**Time devoted to task by <u>each</u> Future Trainer while in contact with team (hours)**			
-----		**In class**	**On floor, interrupted**	**On floor, normal work**	**Knives to collect (total)**
	5.1 Class presentation of the theoretical content of the *Manual for Trainers.* Introduction to steeling, and exercises, according to principles of good practice. Typically a full morning session. Management staff invited to this session.	4c			

	5.2 During the first part of the afternoon, the expert trainer views the technique of each future trainer, in turn, at work on the floor at his work station, with discussion and review of the future trainer's methods and tools for maintaining maximum sharpness of his knife during cutting of meat. The future trainer should not be expected to maintain normal rate of production during this.		1		
	5.3 The ergonomist analyzes the existing arrangements and possibilities for training/apprenticeship at work stations, including self-training.				
	5.4 During the morning of the second day the expert trainer provides a class demonstration and instruction in knife sharpening.	4c			
	5.5 During the afternoon, in class, the expert trainer reviews and comments on the steeling techniques of each future trainer. Each future trainer practices different techniques of steeling. Each future trainer is guided in exercises in the analysis of the techniques of a colleague	4c			
-----	**Fourth visit to plant (Only NL Team): <u>Week of February 6th , Half day</u>** **6. Analysis of the development of the steeling techniques of the future trainer**				
	6.1 Two weeks later, the MUN team videotapes the technique of each future trainer, on the floor at his normal work station. Collection of a knife prepared by each future trainer		1		3

	6.2 Evaluation, at MUN and UQAM, using a standard form, of the knives 6.3 Review at both locations of the technique developed by each future trainer following the training sessions so far and of the analysis of the conditions for training/apprenticeship. Identification of elements to correct in the steeling technique if there are deficiencies in the quality of the knife edges. Teleconference discussion of results and preparation for the next sessions				

Leader	**Fifth visit to plant (NL Team & Nicole Vézina): <u>Week of February 20th, 2 Consecutive Days</u>** **7. Return to training with future trainers**				
-----		**Time devoted to task by <u>each</u> Future Trainer while in contact with team (hours)**			
-----		**In class**	**On floor, interrupted**	**On floor, normal work**	**Knives to collect (total)**
	7.1 During the first morning future trainers work at usual work stations on floor. The expert trainer views each future trainer at steeling, in turn suggesting, as necessary, the elements of his technique he could change, and invites him to try other techniques. The future trainer should not be expected to maintain normal rate of production during this.		1		
	7.2 Simultaneous with above, ergonomist views in class, with each future trainer in turn, the videos taken before and after training, with discussion of the development of his technique, the principles of steeling, and the choice of techniques for future practice.	li			

	7.3 During the afternoon, exercise in class in identification of faulty technique, using video examples. Exercise in the identification of defects in the knife edges using a series of knives and magnified images. 7.4 Collective review in class with all future trainers of the exercises and discussion.	4c			
	7.5 In the morning of the second day, review in class of the *Manual for the Trainer* with the future trainers, selection of sections to include and expand for *Notes for a Trainee* Presentation and review of pedagogical issues relevant in this kind of training.	4c			
	7.6 Review of sharpening techniques with all future trainers.(Future trainers are expected to devote one hour a day to sharpening.)	4c			

Leader	**Sixth visit to plant (Only NL Team): <u>Week of March 6th, 1 Day</u>** **8. Preparation of course material and initial practice in training**				
-----		**Time devoted to task by <u>each</u> Future Trainer while in contact with team (hours)**			
-----		**In class**	**On floor, interrupted**	**On floor, normal work**	**Knives to collect (total)**

	8.1 Preparation by the ergonomist of the *Notes for Tranees* for future trainees. Preparation of materials on the theoretical and practical aspects (documents, examples of knives at different stages, etc.)				
	8.2 Members of NL team return to plant. Each future trainer presents a part of the course in class to the other future trainers, while this is videotaped.. Group discussion of the course content and presentation, on the *Notes for Trainees*, the conditions for training and apprenticeship, and on the organization of training. Corrections suggested for the *Notes for Trainees.*	8c			
	8.3 A knife steeled by each future trainer is collected for examination.				3
-----	**Seventh visit to plant (NL Team & Nicole Vézina): Week of March 13th, 2.5 – 3 Days** **9. Future trainers practice give complete course**				
	9.1 During the first morning future trainers prepare in class to give the complete course.	4c			
	9.2 During the afternoon and the following day, each future trainer, in turn, gives the whole course in class to several people, not other workers but, for instance, students interested in ergonomics and/or a few management personnel, in the presence of his colleagues, the expert trainer, and the ergonomist 9.3 After the course, the expert trainer and the ergonomist give advice on any improvements to the training. The advice is provided later in writing.	8c 4c			
	9.4 Sharpening is reviewed with all future trainers	4c			

	9.5 The team meets with management				
	The course should be given in the plant by the new trainers to other workers before the next visit. **<u>Between March 20th and April 7th (3 weeks)</u>**	4c			
Leader	**Eighth visit to plant (Only NL Team): Week of April 10th** **10. Evaluation of the course** **Several weeks after previous visit**				
-----		**Time devoted to task by <u>each</u> Future Trainer while in contact with team (hours)**			
-----		**In class**	**On floor, interrupted**	**On floor, normal work**	**Knives to collect (total)**
	10.1 Discussion of the course by local team (NV by teleconference) with all the trainers together.	4c			
	10.2 Individual interviews in class with workers trained by the new trainer (two workers selected at random from those trained by each new trainers) who are also videotaped on the floor at their work stations, with the retention of a knife from each. Mini survey administered to all the workers who have been trained by the new trainers, responding anonymously. <u>Total of 6 hours with workers other than future trainers</u>				2
	10.3 Analysis of the interviews, the requirements at the workstations, the sharpening techniques of the trainees, analysis of the knives. Compilation of the results of the mini survey. 10.4 Meeting of the Team by teleconference with expert trainer and the ergonomist 10.5 Preparation of a report on the outcome of the training and organization of the following meeting				

-----	**11. Review with plant management and follow up**				
	11.1 Preparation of a report on the course. 11.2 Meeting of Team (NV by teleconference) with plant management to present of the report on the course and the support within the organization for the course.				
-----	**Total**	63 hrs+ 3 days in Mtl	3	2	

Important Notes:

Knives collected: All knives collected will be returned approximately 3 weeks following removal for analysis. As knives are collected monthly, it is expected that no more than 4 knives will be removed at once. In addition, the number shown is the total for all trainers combined.

Step 10.2 requires a total of 3 hours from each of 2 workers that are not the trainers for a total of 6 hours combined (2 hours for individual interviews in the classroom and 1 on the floor at the work station being videotaped for each worker).

Appendix 2: Knife steeling and work analysis tool

Name:
Start

Number of the steeling		Time on Video	Total time for task		Number of Cuts During Work	1 Number of Passes on Steel: Left	Right	Equal passes?	Time/pass
1	Start								
	Stop		Steeling	00:00.0					
	(Normal work pace)		Work time to next steel	00:00.0					
Number of the steeling									
2	Start								
	Stop		Steeling	00:00.0					
	(Normal work pace)		Work time to next steel	00:00.0					
Number of the steeling									
3	Start								
	Stop		Steeling	00:00.0					
	(Normal work pace)		Work time to next steel	00:00.0					
Number of the steeling									
4	Start								
	Stop		Steeling	00:00.0					
	(Normal work pace)		Work time to next steel	00:00.0					
Number of the steeling									
5	Start								
	Stop		Steeling	00:00.0					
	(Normal work pace)		Work time to next steel	00:00.0					
Number of the steeling									
6	Start								
	Stop		Steeling	00:00.0					
	(Normal work pace)		Work time to next steel	00:00.0					
Number of the steeling									
7	Start								
	Stop		Steeling	00:00.0					
			Work time to next steel	00:00.0					
8	Start								
	Stop		Steeling	00:00.0					
	(Normal work pace)		Work time to next steel	00:00.0					
Number of the steeling									
9	Start								
	Stop		Steeling	00:00.0					
	(Normal work pace)		Work time to next steel	00:00.0					

ANALYSIS GRID OF STEELING TECHNIQUES
Observation BEFORE the training

Name of the analyst : ____________________ **Analysis date:** ________
Name of the futur trainer: ____________________ **Company:** ____________

Steeling number	*Time of steeling (on video)*	*Length of steeling (seconds)*	*Number of passes on the steel*	*Number of piecs before each steel*	*Coments (cleaning, etc.)*
1		00:00.0	0	1	
2		00:00.0	0	0	
3		00:00.0	0	0	
4		00:00.0	0	0	
5		00:00.0	0	0	
6		00:00.0	0	0	
7		00:00.0	0	0	
8		00:00.0	0	0	
9		00:00.0	0		
Total:	00:00.0	00:00.0			

Observable Characteristics	*Observations*	*Comments*	***Personal data sheet***	
Looking at the blade			*Workstation*	
Concentration				
Way of holding knife				
Knife stability			*Age*	
Coordinated movements			*Height*	
Avoids tip of knife			*Dominant hand*	
Alternating on the steel			*Seniority domaine*	
Equal number of passes			*Seniority company*	
Steel position			*Seniority workstation*	
Blade: perpendicular to steel			*Prior training*	
Cutting side up or down				
Length of blade steeling			*Voluntary / Designated*	
Mouvement: blade going up or down				
Length of steel used			*to become trainer*	
Cleaning knife before			*Sharpen*	
Pressure on blade				

Appendix 3: Quiz on steeling and employee questionnaire

Knife Steeling Training

Quiz & Questionnaire

Company name: ___________________

Department / Station: ________________________

SECTION 1: QUIZ ON STEELING KNOWLEDGE

1. **The goal of steeling is to:**

   Get the cutting-edge back
   Re-center the cutting edge
   Remove the cutting edge

2. **Steeling requires what level of concentration?**

   Low Medium High

3. **To steel effectively, it is recommended to strike the steel:**

   Few times
   Many times

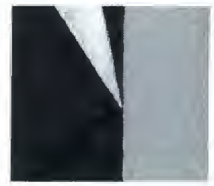
4. **To steel effectively, it is recommended to pass the knife on the steel:**

   Rapidly
   Slowly

5. **While steeling, the pressure from the knife on the steel must be:**

Strong Medium Weak Very weak

6. Which technique will enable the knives to be steeled?

A.  B.  C. 

7. Which joint (on the side of the hand holding the knife) should remain stable while steeling?

Shoulder Elbow Wrist

SECTION 2 : BRIEF QUESTIONAIRRE ON TRAINING PROCESS

Do you agree or disagree with the following statements:

1) You were given enough time to use and practice the new steeling method skills over the recent months while at your workstation.

Strongly Disagree	**Disagree**	**Agree**	**Strongly Agree**

|___||___||___||___||___||___||___||___||___||___|

If you feel the time permitted was less then adequate, what are the factors that influenced the lack of available time?

____

2) **Proper equipment and support (ie: steels, knives, trainer availability) were given after I was trained.**

Strongly Disagree	**Disagree**	**Agree**	**Strongly Agree**

|___||___||___||___||___||___||___||___||___||___|

Any comments, positive or negative, on the support I was given:

____

____

____

____

____

____

3) **I could decide whether to be trained in the new technique or not.**

Strongly Disagree	**Disagree**	**Agree**	**Strongly Agree**

|___||___||___||___||___||___||___||___||___||___|

4) **Now that I have been trained, I can decide whether to use the new technique or not.**

Strongly Disagree	Disagree	Agree	Strongly Agree

|___||___||___||___||___||___||___||___||___||___|

5) **I feel I can have a say in whether or how the new technique will be used in this plant in the future.**

Strongly	**Disagree**	**Agree**	**Strongly**

Disagree **Agree**

|____| |____| |____| |____| |____| |____| |____| |____| |____| |___|

6) The new knife steeling and sharpening techniques can benefit other areas of the plant and they should be implemented as soon as possible."

Strongly Disagree **Disagree** **Agree** **Strongly Agree**

|____| |____| |____| |____| |____| |____| |____| |____| |____| |___|

7) I am confident that both the company and the employees will continue to use the sharpening and steeling skills in day-to-day operations long after the research project has ended.

Strongly Disagree **Disagree** **Agree** **Strongly Agree**

|____| |____| |____| |____| |____| |____| |____| |____| |____| |___|

8) Are you able to properly follow the cutting edge of your knife while steeling?

always
most of the time
from time to time
rarely
never

9) Are you satisfied with the training you received?

not at all satisfied
partly satisfied
satisfied
very satisfied

10) **How would you rank the sharpness of your knife?**

BEFORE THE TRAINING

0% 50% 100% sharp

|____| |____| |____| |____| |____| |____| |____| |____| |____| |____|

AFTER THE TRAINING

0% 50% 100% sharp

|____| |____| |____| |____| |____| |____| |____| |____| |____| |____|